L Number	Hits	Search Text	DB	Time stamp
1	0	pins adj retrofit and "catch basin"	USPAT; US-PGPUB; EPO; JPO; DERWENT; IBM_TDB	2002/12/02 16:03
2	86	pins and connector and "catch basin"	USPAT; US-PGPUB; EPO; JPO; DERWENT; IBM_TDB	2002/12/02 16:07
3	13	("0477758" | "1249786" | "1276079" | "1539051" | "1808402" | "2654508" | "3007256" | "3249954" | "3575481" | "4052227" | "4054184" | "4085987" | "4265283").PN.	USPAT	2002/12/02 16:06
4	0	pins and connector and "catch basin module"	USPAT; US-PGPUB; EPO; JPO; DERWENT; IBM_TDB	2002/12/02 16:07
5	0	"catch basin module"	USPAT; US-PGPUB; EPO; JPO; DERWENT; IBM_TDB	2002/12/02 16:08
6	0	"catch basin " and module and "backplane"	USPAT; US-PGPUB; EPO; JPO; DERWENT; IBM_TDB	2002/12/02 16:09
7	0	"catch basin " and "backplane"	USPAT; US-PGPUB; EPO; JPO; DERWENT; IBM_TDB	2002/12/02 16:10
8	427	cabinet and back near plane	USPAT; US-PGPUB; EPO; JPO; DERWENT; IBM_TDB	2002/12/02 16:10
9	2	cabinet and back near plane and hosing and pin and connector	USPAT; US-PGPUB; EPO; JPO; DERWENT; IBM_TDB	2002/12/02 16:11
10	69	cabinet and back near plane and housing and pin and connector	USPAT; US-PGPUB; EPO; JPO; DERWENT; IBM_TDB	2002/12/02 16:25

11	2	("5494451" | "6269007").PN.	USPAT	2002/12/02 16:16
12	6	("4699270" | "5173845" | "5398161" | "5790518" | "6007169" | "6053808").PN.	USPAT	2002/12/02 16:18
13	10	("3675083" | "3992654" | "4002381" | "4134631" | "4151580" | "4250536" | "4470100" | "4573753" | "4602829" | "4893405").PN.	USPAT	2002/12/02 16:20
14	171	switch adj module and window and pin	USPAT; US-PGPUB; EPO; JPO; DERWENT; IBM_TDB	2002/12/02 16:30
15	0	switch adj module and "catch module"	USPAT; US-PGPUB; EPO; JPO; DERWENT; IBM_TDB	2002/12/02 16:30
16	0	"catch basin module"	USPAT; US-PGPUB; EPO; JPO; DERWENT; IBM_TDB	2002/12/02 16:31
17	1	"catch basin " and module and 29/$.ccls.	USPAT; US-PGPUB; EPO; JPO; DERWENT; IBM_TDB	2002/12/02 16:33
18	16	("Re33780" | "4768647" | "4809839" | "4880106" | "4952109" | "4995157" | "5116185" | "5153983" | "5154316" | "5155903" | "5184716" | "5208969" | "5295294" | "5329692" | "5337465" | "5509201").PN.	USPAT	2002/12/02 16:32
19	103	"catch basin " and module	USPAT; US-PGPUB; EPO; JPO; DERWENT; IBM_TDB	2002/12/02 16:35
20	9	"catch basin" and telecommunications	USPAT; US-PGPUB; EPO; JPO; DERWENT; IBM_TDB	2002/12/02 16:36
21	585	cabinet and module and telecommunications	USPAT; US-PGPUB; EPO; JPO; DERWENT; IBM_TDB	2002/12/02 16:37

22	54	cabinet and module and telecommunications and 439/$.ccls.	USPAT; US-PGPUB; EPO; JPO; DERWENT; IBM_TDB	2002/12/02 16:49
23	2	("5497444" | "5552962").PN.	USPAT	2002/12/02 16:44
24	98	(cabinet or basin) and telecommunications and 439/$.ccls.	USPAT; US-PGPUB; EPO; JPO; DERWENT; IBM_TDB	2002/12/02 16:59
25	96	(cabinet or"catch basin") and telecommunications and 439/$.ccls.	USPAT; US-PGPUB; EPO; JPO; DERWENT; IBM_TDB	2002/12/02 16:59
26	1515	(cabinet or"catch basin") and telecommunications	USPAT; US-PGPUB; EPO; JPO; DERWENT; IBM_TDB	2002/12/02 16:59
27	9	"catch basin" and telecommunications	USPAT; US-PGPUB; EPO; JPO; DERWENT; IBM_TDB	2002/12/02 17:00
28	132	module and telecommunications and chassis and backplane and slot	USPAT; US-PGPUB; EPO; JPO; DERWENT; IBM_TDB	2002/12/02 17:18
29	12	("1175865" | "1396876" | "1873534" | "4502609" | "4517623" | "5223670" | "5262588" | "5561893" | "5691503" | "5691504" | "5701231" | "5726684").PN.	USPAT	2002/12/02 17:09
31	0	telecommunications and chassis and backplane and slot and "catch basin" near module	USPAT; US-PGPUB; EPO; JPO; DERWENT; IBM_TDB	2002/12/02 17:19
32	3	telecommunications and chassis and backplane and slot and electronic near module	USPAT; US-PGPUB; EPO; JPO; DERWENT; IBM_TDB	2002/12/02 17:26
33	18	("3700820" | "3717813" | "3934224" | "4009343" | "4090220" | "4107470" | "4135202" | "4290142" | "5267122" | "5343361" | "5351245" | "5455739" | "5499047" | "5553064" | "5592540" | "5594726" | "5659351" | "5828807").PN.	USPAT	2002/12/02 17:22

34	18	("3700820" | "3717813" | "3934224" | "4009343" | "4090220" | "4107470" | "4135202" | "4290142" | "5267122" | "5343361" | "5351245" | "5455739" | "5499047" | "5553064" | "5592540" | "5594726" | "5659351" | "5828807").PN.	USPAT	2002/12/02 17:23
35	7	("3634732" | "4027206" | "4203147" | "4441140" | "4498119" | "4546407" | "5243493").PN.	USPAT	2002/12/02 17:24
36	11	("4090067" | "4358858" | "4727600" | "4796301" | "5247381" | "5455672" | "5493436" | "5818619" | "5983068" | "6091528" | "6239888").PN.	USPAT	2002/12/02 17:25
37	462	361/727.ccls.	USPAT; US-PGPUB; EPO; JPO; DERWENT; IBM_TDB	2002/12/02 17:26
38	19	361/727.ccls. and module near housing	USPAT; US-PGPUB; EPO; JPO; DERWENT; IBM_TDB	2002/12/02 17:29
39	0	361/727.ccls. and module and "catch basin"	USPAT; US-PGPUB; EPO; JPO; DERWENT; IBM_TDB	2002/12/02 17:30
40	0	361/$.ccls. and module and "catch basin"	USPAT; US-PGPUB; EPO; JPO; DERWENT; IBM_TDB	2002/12/02 17:30
41	79	361/732.ccls. and module	USPAT; US-PGPUB; EPO; JPO; DERWENT; IBM_TDB	2002/12/02 17:37
42	520	361/704.ccls. and module	USPAT; US-PGPUB; EPO; JPO; DERWENT; IBM_TDB	2002/12/02 17:38
43	23	361/704.ccls. and module and "backplane"	USPAT; US-PGPUB; EPO; JPO; DERWENT; IBM_TDB	2002/12/02 17:46
44	4	("5128830" | "5411416" | "5757617" | "6104613").PN.	USPAT	2002/12/02 17:40
45	4	("5128830" | "5411416" | "5757617" | "6104613").PN.	USPAT	2002/12/02 17:45

46	2	174/50.51.ccls. and module and "backplane"	USPAT; US-PGPUB; EPO; JPO; DERWENT; IBM_TDB	2002/12/02 17:46
47	42	29/$.ccls. and module and "backplane"	USPAT; US-PGPUB; EPO; JPO; DERWENT; IBM_TDB	2002/12/02 17:52
48	1018	29/$.ccls. and module and housing	USPAT; US-PGPUB; EPO; JPO; DERWENT; IBM_TDB	2002/12/02 17:54
49	8	29/$.ccls. and module and housing and retrofit	USPAT; US-PGPUB; EPO; JPO; DERWENT; IBM_TDB	2002/12/02 17:55
50	0	29/$.ccls. and module and housing and casing and pin and connectoretrofit	USPAT; US-PGPUB; EPO; JPO; DERWENT; IBM_TDB	2002/12/02 17:55
51	29	29/$.ccls. and module and housing and casing and pin and connector	USPAT; US-PGPUB; EPO; JPO; DERWENT; IBM_TDB	2002/12/02 17:58
52	55	29/$.ccls. and module and casing and pin and connector	USPAT; US-PGPUB; EPO; JPO; DERWENT; IBM_TDB	2002/12/02 18:02
53	44	29/$.ccls. and module and communications near system	USPAT; US-PGPUB; EPO; JPO; DERWENT; IBM_TDB	2002/12/02 18:05
54	638	29/$.ccls. and module and communications	USPAT; US-PGPUB; EPO; JPO; DERWENT; IBM_TDB	2002/12/02 18:06
55	261	29/$.ccls. and module and communications and housing	USPAT; US-PGPUB; EPO; JPO; DERWENT; IBM_TDB	2002/12/02 18:06

56	10	29/$.ccls. and module and communications and housing and "backplane"	USPAT; US-PGPUB; EPO; JPO; DERWENT; IBM_TDB	2002/12/02 18:12
57	20	("3188601" | "3707696" | "3950070" | "3989336" | "4092057" | "4248491" | "4576427" | "4621305" | "4639057" | "4743080" | "4784615" | "5009607" | "5240420" | "5342203" | "5482473" | "5667389" | "5871362" | "5928027" | "5954536" | "6109928").PN.	USPAT	2002/12/02 18:10
58	9	("4454414" | "4704775" | "4866572" | "5153839" | "5179775" | "5198983" | "5221838" | "5265150" | "5460441").PN.	USPAT	2002/12/02 18:11
59	10	("1033758" | "2584124" | "2677426" | "3159393" | "3536133" | "3588983" | "4148534" | "4175734" | "4636725" | "4713611").PN.	USPAT	2002/12/02 18:11
60	97540	(Erwin charles).inv.	USPAT; US-PGPUB; EPO; JPO; DERWENT; IBM_TDB	2002/12/02 18:13
61	4	(Erwin adj charles) .inv.	USPAT; US-PGPUB; EPO; JPO; DERWENT; IBM_TDB	2002/12/02 18:14
62	0	(Erwin adj charles) .inv. and module	USPAT; US-PGPUB; EPO; JPO; DERWENT; IBM_TDB	2002/12/02 18:14
63	242	(Erwin) .inv. and module	USPAT; US-PGPUB; EPO; JPO; DERWENT; IBM_TDB	2002/12/02 18:16
64	8	(Erwin) .inv. and module and telecommunications	USPAT; US-PGPUB; EPO; JPO; DERWENT; IBM_TDB	2002/12/02 18:16

US005757617A

United States Patent [19]

Sherry

[11] Patent Number: 5,757,617

[45] Date of Patent: May 26, 1998

[54] MODULE WITH SNAP-FIT COVER

[76] Inventor: Raymond C. Sherry, 4221 Saint Leger Dr., Cleburne, Tex. 76031

[21] Appl. No.: 697,066

[22] Filed: Aug. 19, 1996

[51] Int. Cl.[6] G06F 1/16; H05K 5/03; H05K 7/10; G11B 33/12

[52] U.S. Cl. 361/685; 361/727; 361/730; 361/802; 206/387.15

[58] Field of Search 364/708.1; 206/387.15, 206/387.1, 309; 220/3.7, 3.8, 4.32, 4.33, 4.02, 784, 785, 787, 752, 766; 361/683–687, 694, 695, 730, 736, 737, 741, 752, 756, 802, 725, 727

[56] References Cited

U.S. PATENT DOCUMENTS

4,652,969 3/1987 Stegenga 361/694

5,235,493 8/1993 Yu 361/685

Primary Examiner—Michael W. Phillips

Attorney, Agent, or Firm—Sidley & Austin

[57] ABSTRACT

A chassis assembly housing a plurality of modules, each module having a rigid case with four beveled corners. Small contact area guide rails in the chassis engage each module to provide a high precision alignment between high density contacts of the chassis backplane, and the back side of each module. Each module has a side lid that is snap fit for easy removal thereof and access to the circuit components housed within the module case. Each module, which is about the size of a cigarette package, can accommodate hundreds if socket contacts which mate with corresponding pins in the chassis backplane.

35 Claims, 8 Drawing Sheets

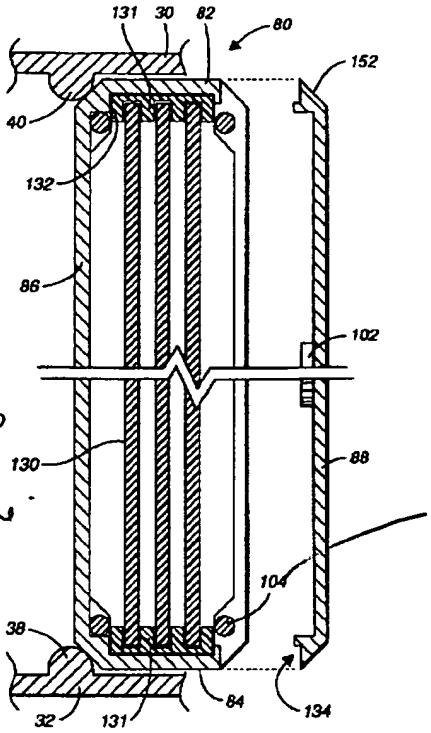


Fig 9. shows Rear + connect to Module 16.

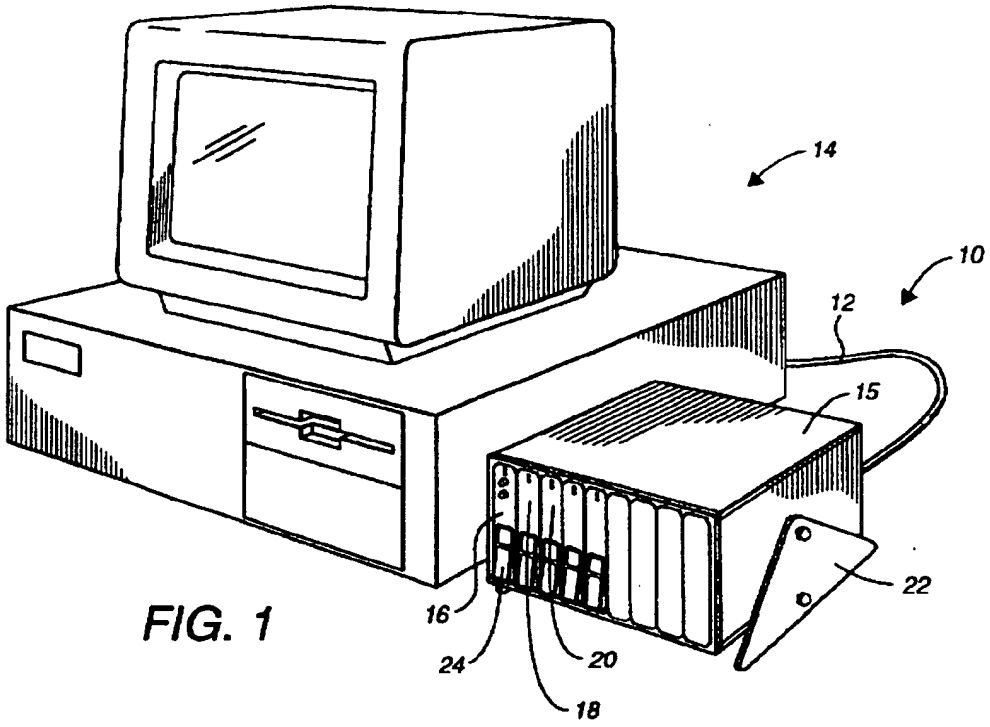

14
10
12
15
22
16
24
20
18

FIG. 1

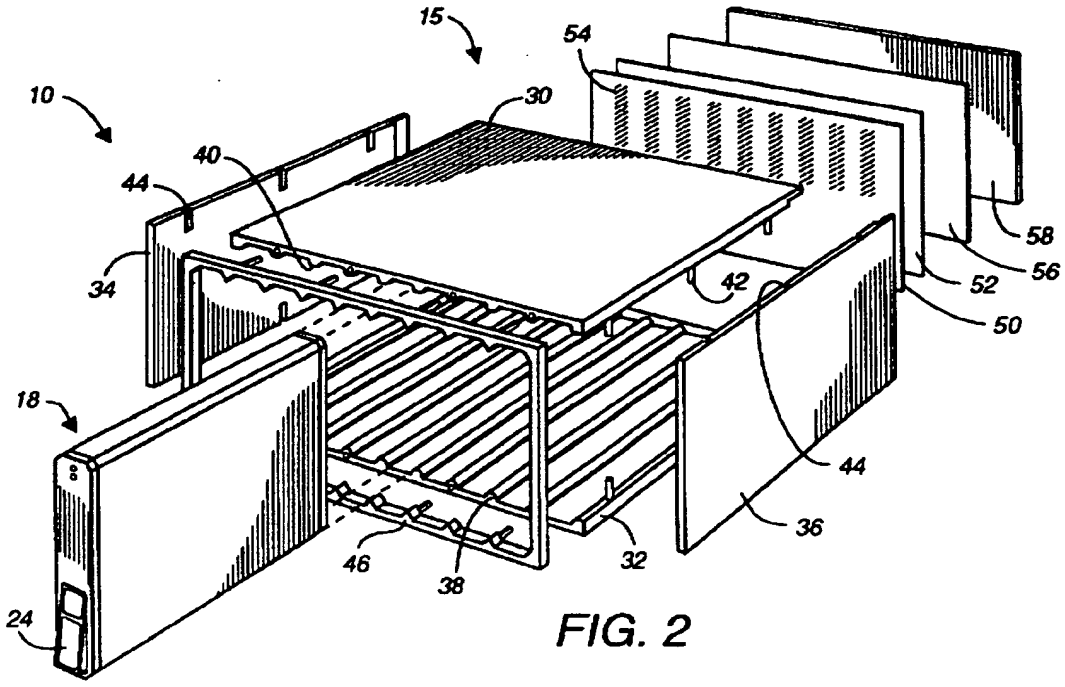

15
54
10
30
40
44
58
56
34
52
42
50
18
44
36
46
38
32
24

FIG. 2

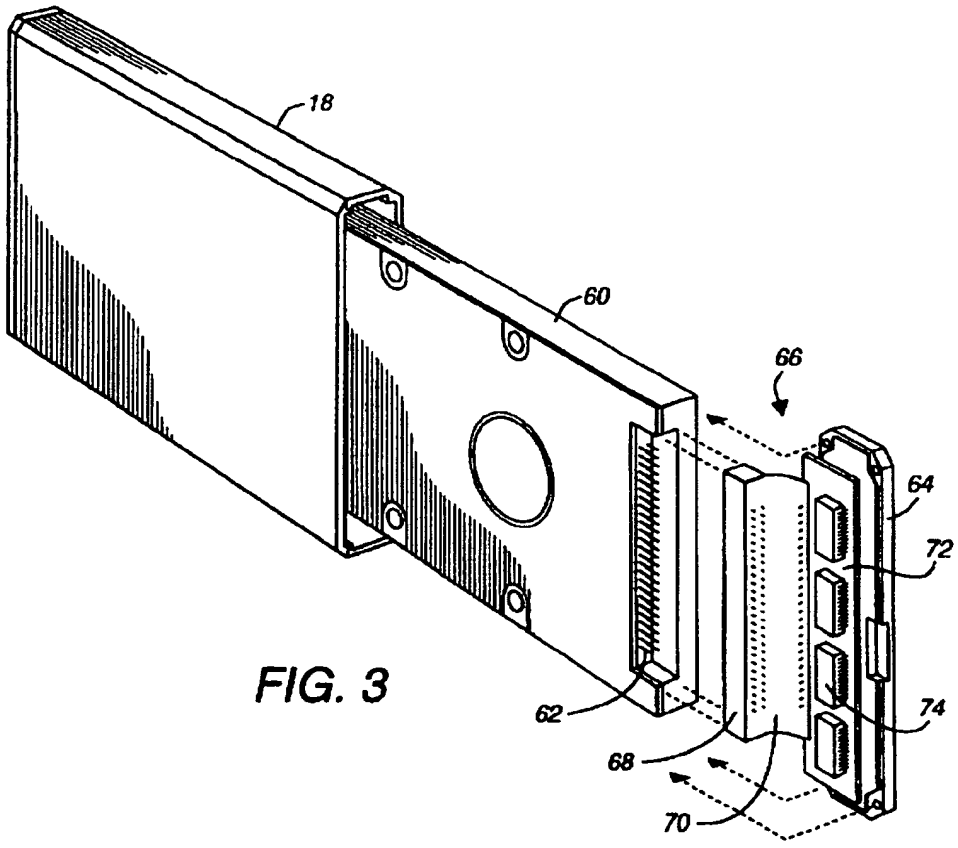

18
60
66
64
72
74
62
68
70

FIG. 3

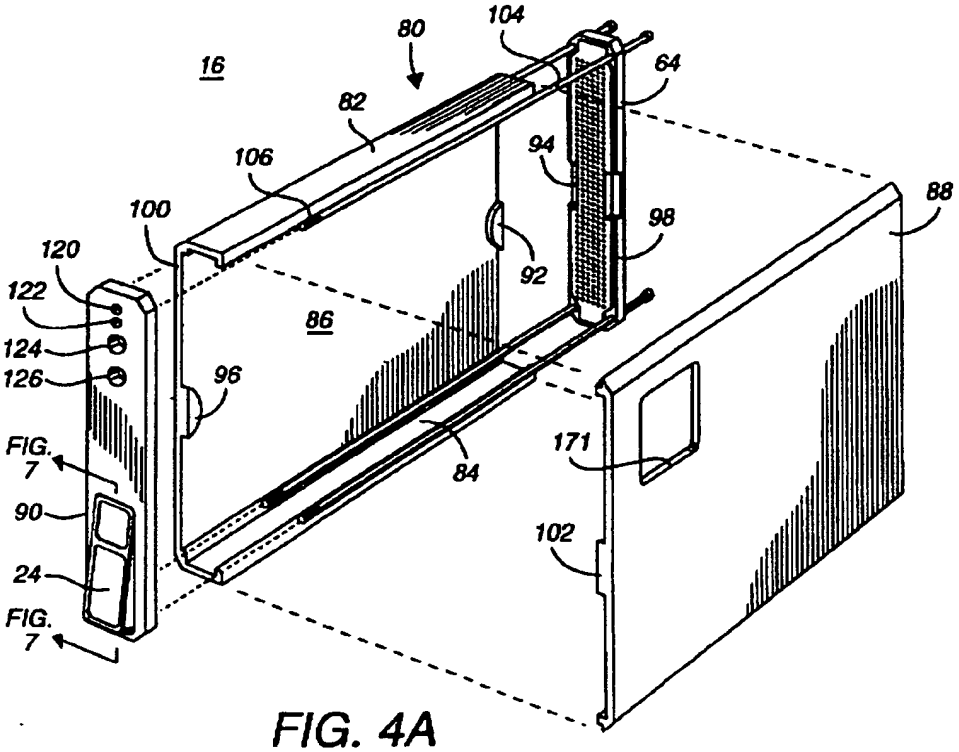

80
104
16
64
82
106
94
88
100
98
120
92
122
86
124
126
96
FIG. 7
171
84
90
102
24
FIG. 7

FIG. 4A

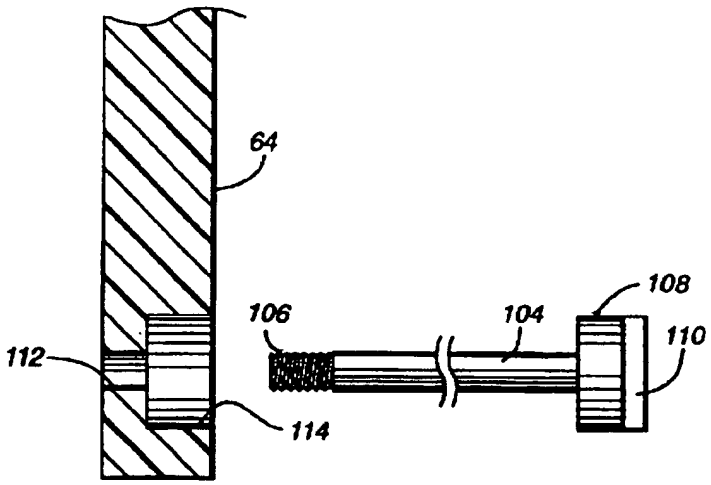


FIG. 4B

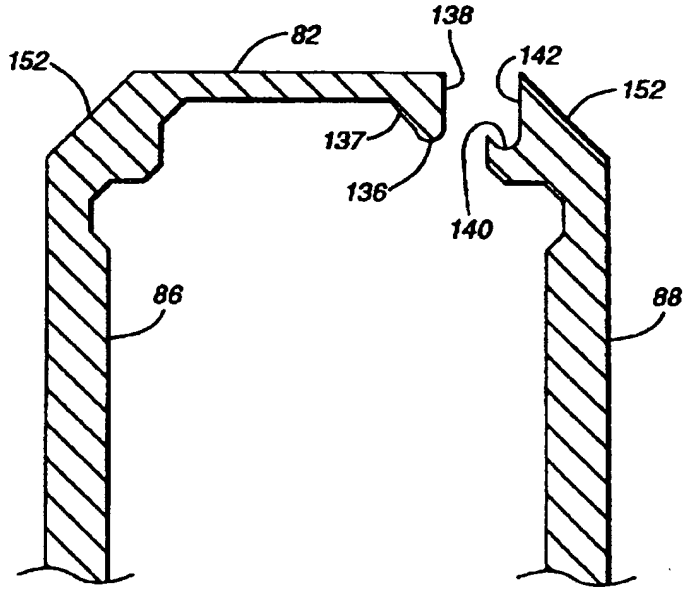


FIG. 5B

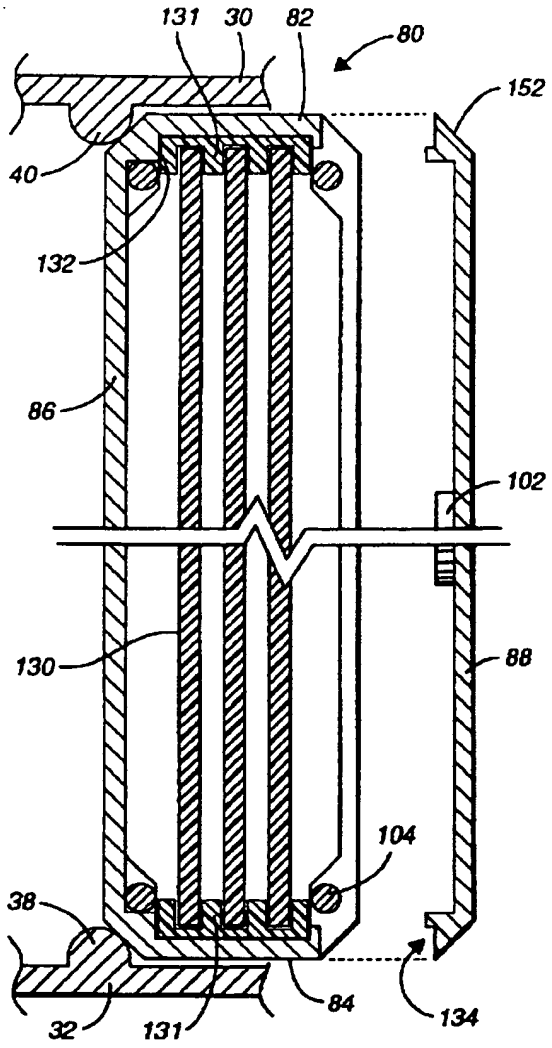


FIG. 5A

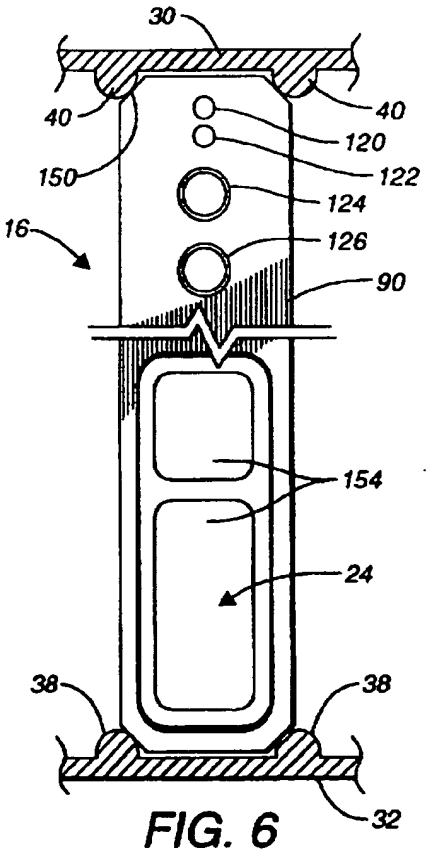


FIG. 6

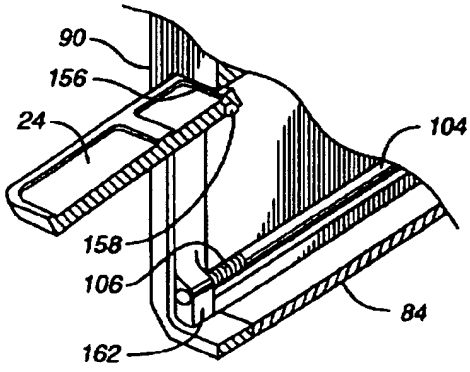


FIG. 7

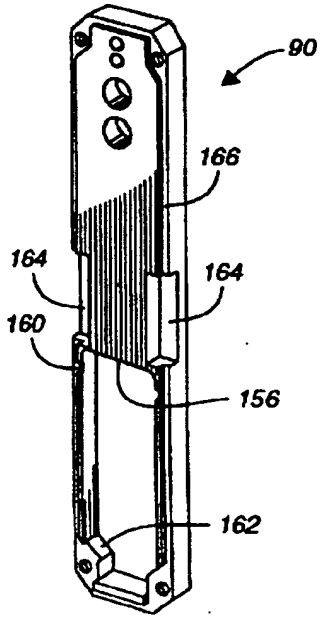


FIG. 8

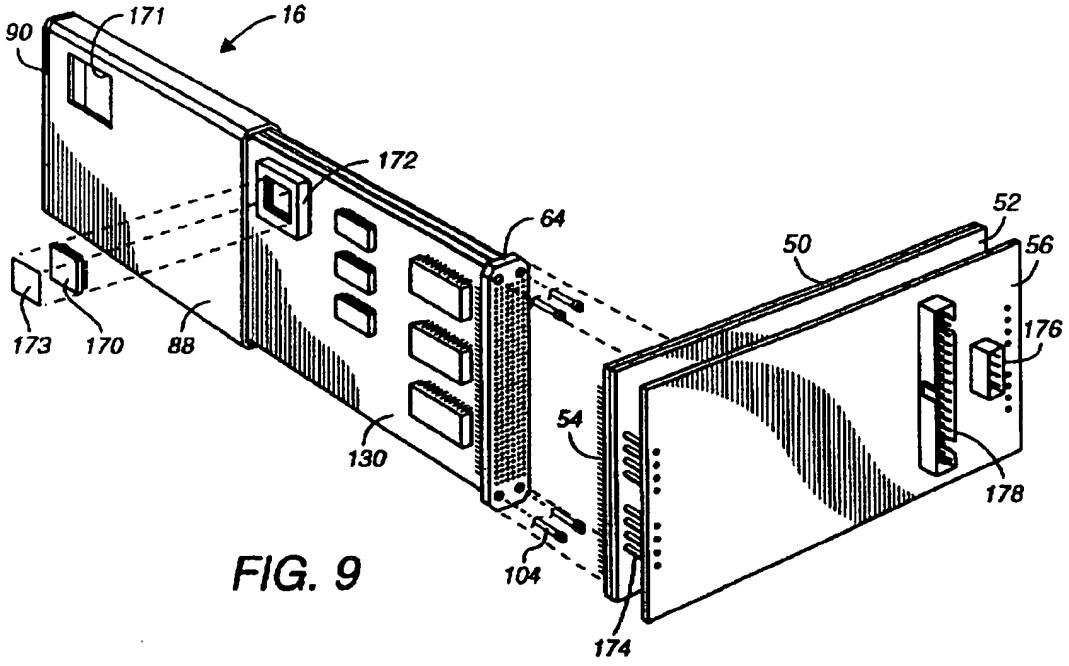

90
171
16
172
64
52
50
56
176
173
170
88
54
130
178
104
174

FIG. 9

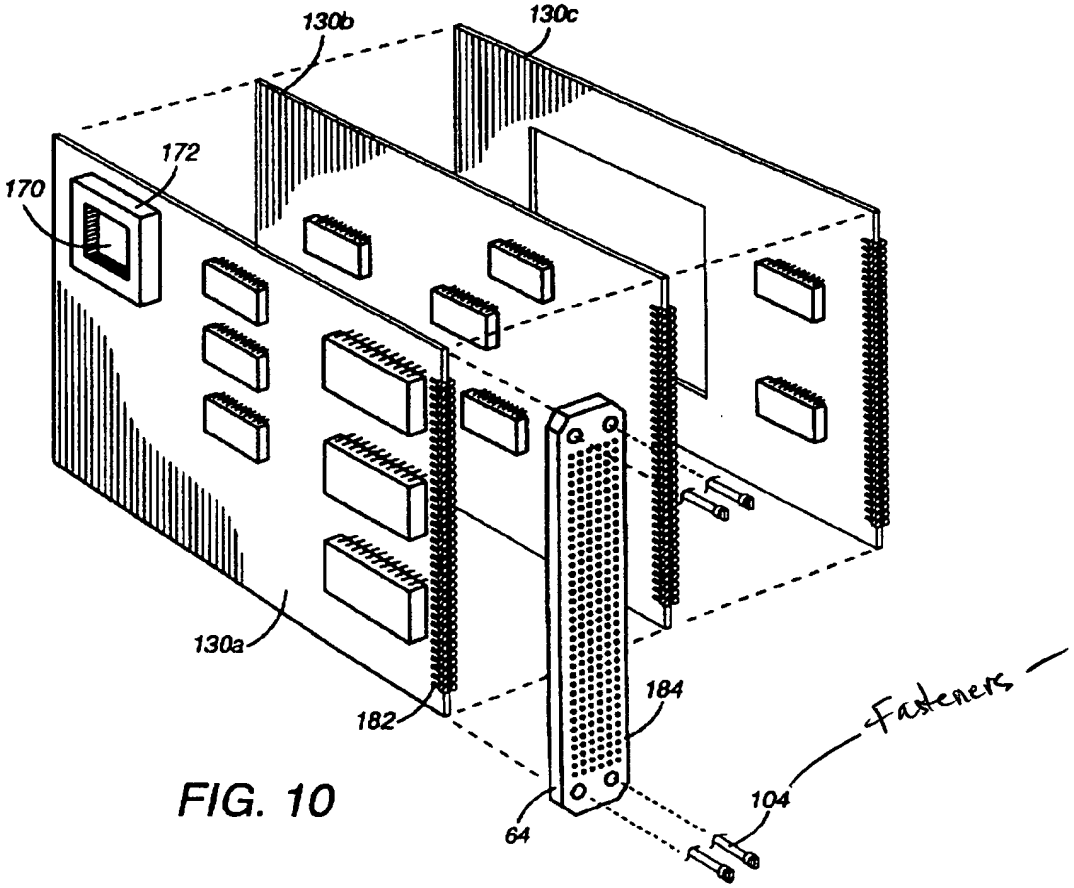

130b
130c
172
170
130a
182
184
Fasteners
104
64

FIG. 10

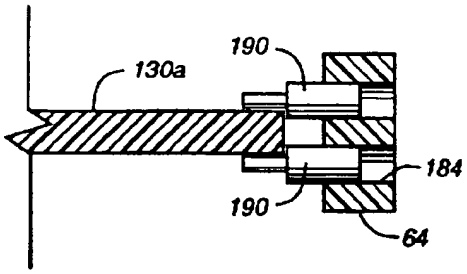


FIG. 11

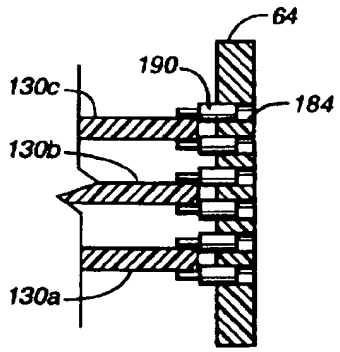


FIG. 12

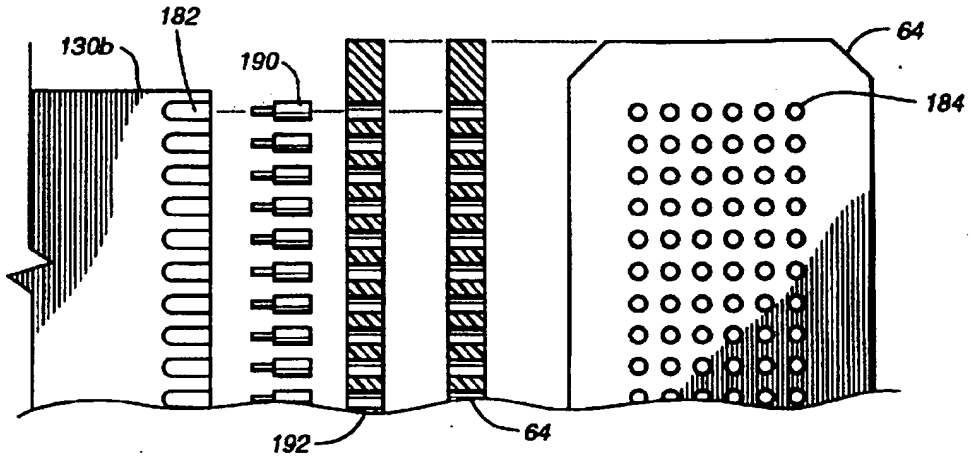


FIG. 13

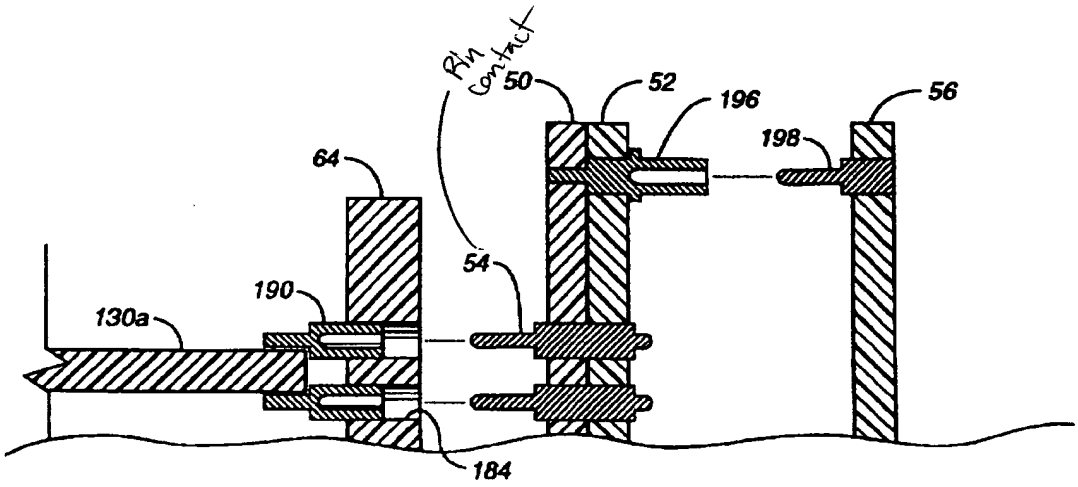


FIG. 14

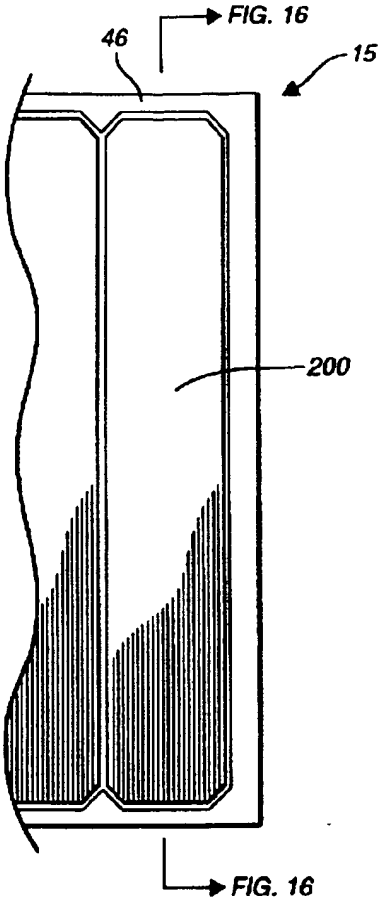


FIG. 15

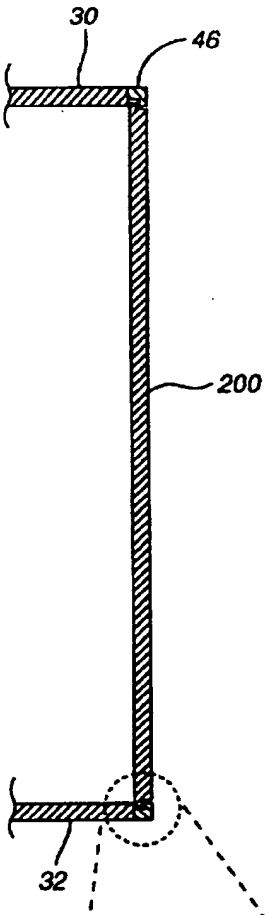


FIG. 16

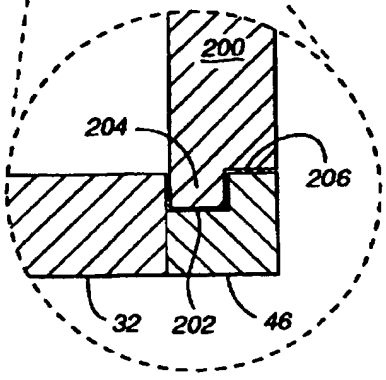


FIG. 17

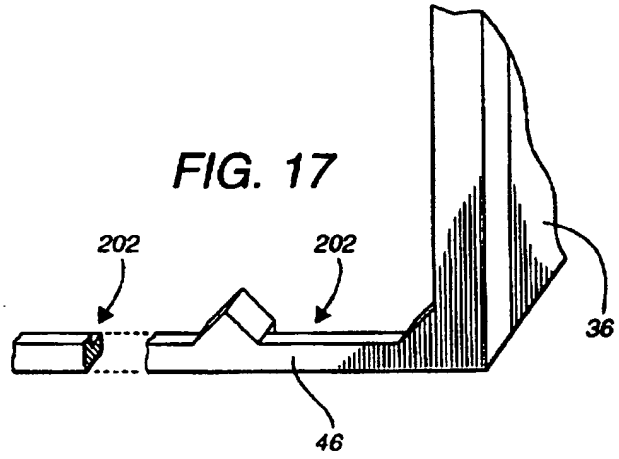
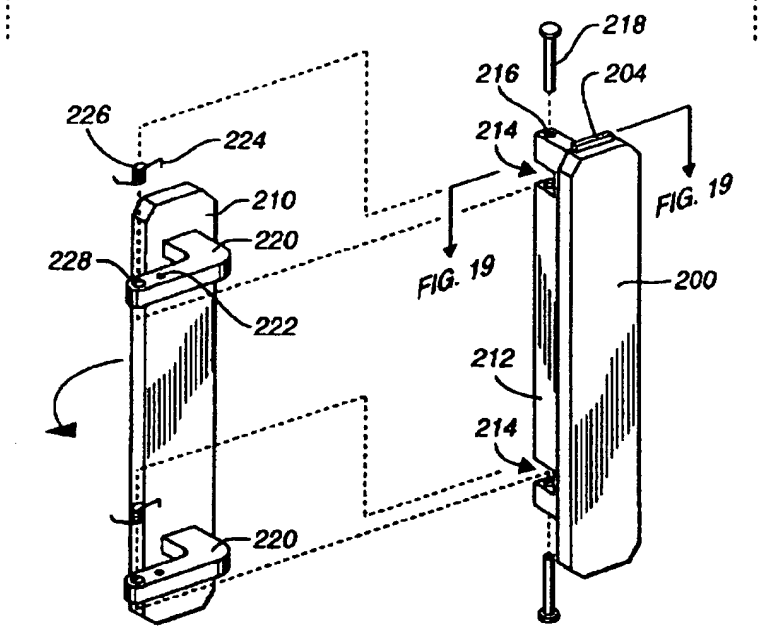


FIG. 18


218
216
204
214
226
224
210
220
228
222
FIG. 19
FIG. 19
200
212
214
220

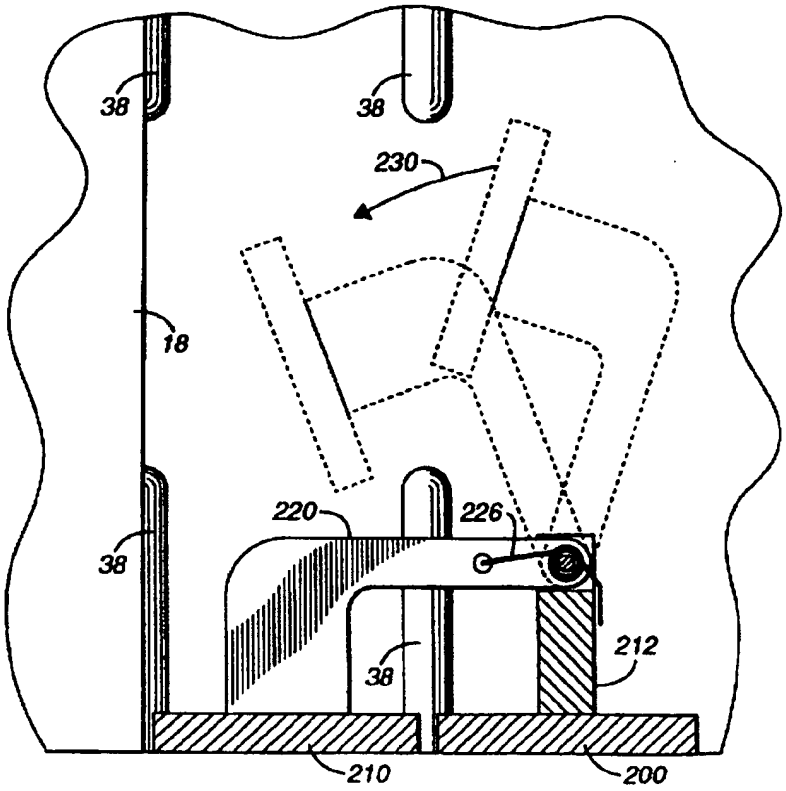

38
38
230
18
220
226
38
212
38
210
200

FIG. 19

MODULE WITH SNAP-FIT COVER

TECHNICAL FIELD OF THE INVENTION

The present invention relates in general to the compact integration of circuit modules in a chassis, and more particularly to a technique for providing a high density interconnection between multi-pin circuit modules, by way of a high density conductor chassis backplane.

BACKGROUND OF THE INVENTION

Constant efforts are directed toward the miniaturization of electrical circuits and components to thereby increase the circuit density per unit area. The integrated circuit technology has made significant advances in the development of the semiconductor layout, masking equipment, steppers, etc., to thereby form a greater number of transistor circuits onto a smaller area of the semiconductor material. Further, the miniaturization of components and the hybridization thereof into encapsulated modules is an ongoing endeavor toward the miniaturization of electrical circuits. Advantage is taken of the smaller size of the components, encapsulated modules, integrated circuits, etc., by allowing many more of such components to be interconnected on a printed circuit board. Indeed, printed circuit boards themselves have multiple layers of conductors, as well as high density conductors to thereby facilitate the interconnection of the many components mounted thereto.

Notwithstanding the ongoing miniaturization of components, such components are still required to be interconnected together not only by way of the printed circuit boards noted above, but such printed circuit boards, or modules, are also often interconnected together in a chassis. A common technique for housing a number of printed circuit modules is to provide metallic contacts on one or both opposing edge surfaces of the printed circuit board, and a corresponding female connector mounted in the chassis. In this manner, when the printed circuit board is inserted into the chassis by way of guide rails, the edge conductors automatically mate with corresponding connector contacts. Moreover, the connectors are interconnected with other connectors by wires that are often manually or automatically wound around terminals extending from the connector. Instead of the hard wired interconnections between chassis connectors, a multi-layer backplanes are often utilized to provide the interconnections between the connectors. In this instance, the connector terminals are soldered into the backplane conductors. Although this printed circuit board backplane is relatively expensive, it reduces the time required to assemble a complete chassis and connector interconnections.

While the foregoing chassis assembly functions very well for its intended purpose, a problem arises when it is desired to increase the number of connections between the printed circuit modules and the connectors. One approach has been to simply extend the length of the printed circuit board edge to accommodate more contacts, but this solution requires a larger connector and chassis. Another technique is to mount a separate, small printed wire board to the printed circuit board, but spaced therefrom, with wiring interconnecting the two, so that a pair of edge connectors can be utilized for the circuit module. Yet another approach has simply been to reduce the size and spacing between the edge contacts of a printed circuit board, thereby increasing the density of the contacts. This technique can be utilized to the extent that the contact surface area is reduced until inadequate metallic contact area exists to carry the requisite electric current.

While the utilization of printed circuit boards with components soldered thereto has experienced a significant success, inherent disadvantages still exist. For example, the components extending from the printed circuit board are subject to damage especially when stacked or inventoried together, without packing material therebetween. Further, the physical handling of such circuit boards when inserting or removing the same from the chassis, subjects the exposed components to damage or short circuiting with other components.

It can be seen from the foregoing that a need exists for an improved printed circuit module design that provides protection to the components thereof from the environment, as well as provides a high degree of interconnectivity to a backplane. A further need exists for a technique to provide self-alignment of high density pins/sockets between a printed circuit module and a backplane to thereby prevent bending or misalignment of the respective pins and sockets. Yet another need exists for an interconnection technique between a high density socket of the printed circuit module, and a corresponding high density pin arrangement of a backplane, while yet maintaining the assembly procedure relatively uncomplicated and maintaining a high degree of reliability.

SUMMARY OF THE INVENTION

In accordance with the principles and concepts of the present invention, there is disclosed a chassis assembly that provides a high degree of interconnectability between the printed circuit modules by way of a high density conductor backplane. In accordance with other aspects of the invention, the printed circuit modules are enclosed so as to protect the components from physical damage, while yet allowing easy accessability to the components when adjustment or repair is required. Further, the particular sliding engagement employed between the printed circuit modules and the chassis guide rails provide a high degree of alignment between the high density pins and sockets.

In accordance with the preferred embodiment of the invention, a module case provides physical protection to one or more printed circuit boards housed therein. Each printed circuit board has a back edge thereof with miniature socket contacts soldered to corresponding pads on each side thereof, thereby providing a high density of interconnections to corresponding miniature pin contacts in a chassis backplane. The socket members of each printed circuit board are maintained aligned and housed within an insulator board to thereby prevent physical damage or misalignment of the individual sockets. The protective case of each multi-board module is preferably formed of a metallic material to provide a high degree of heat transfer from the module to the chassis via the guide rails. Further, each protective case is formed so as to have one vertical metallic side thereof removable, thereby exposing the components for repair or adjustment. The side cover of the case is removably attached by way of a snap-lock arrangement. A faceplate portion of the case includes a hinged pull-tab to allow easy removal of the module from the chassis. The module is retained in the chassis by way of the sliding friction contact between the miniature pins and sockets.

The protective case that houses one or more printed circuit boards, or other types of electronic assemblies, is preferably pocket-sized for easy transporting of the same. Further, each case does not have four right angle corners for sliding into the chassis rails, but rather has beveled or chamfered corner edges, each of which engages by way of

a small-area rounded guide edge of the chassis. In this manner, the module is aligned or registered by way of these four contact surfaces to thereby provide a high degree of alignment between the module socket contacts and the backplane pin contacts. Further, the sliding surfaces are anodized to facilitate the sliding action between the module case and the chassis guide rails.

According to another feature of the invention, the chassis is provided with a number of module openings which need not accommodate a module but rather may have snap fit therein a blank faceplate. The blank faceplate provides a decorative cover to an unused slot opening, and prevents dust and particles from easily entering the chassis. Another feature of the invention is that the blank faceplate can be constructed with a hinged cover member fastened to the back side thereof, and spring loaded so that when the blank faceplate is snap locked into the slot opening, the hinged cover pivots Internal to the chassis to provide a cover to an adjacent slot opening. When the adjacent slot has inserted therein a module case, the spring loaded cover is pivoted out of the path of the module as it is inserted into the adjacent slot opening. When the module case is removed, the hinged cover returns to a position in which the slot opening is covered.

BRIEF DESCRIPTION OF THE DRAWINGS

Further features and advantages will become more apparent from the following and more particular description of the preferred and other embodiments of the invention, as illustrated in the accompanying drawings in which like reference characters generally refer to the same elements or parts throughout the views, and in which:

FIG. **1** is an isometric view of a desk top chassis assembly operating in conjunction with a personal computer;

FIG. **2** is an isometric view of the various components of the chassis, with the parts shown in exploded form, and with a circuit module case shown insertable therein;

FIG. **3** is an isometric view of a hard disk drive unit insertable into a module case, with the disk drive unit being connectable to a socket connector which also holds electronic components;

FIG. **4A** is an isometric view of the component parts of a module case, shown in exploded form;

FIG. **4B** is an enlarged partial sectional view of the fastener hole formed in the socket contact collector;

FIG. **5A** is a sectional view of a module case with three circuit boards held therein, and with the side cover shown removed therefrom;

FIG. **5B** is an enlarged and partial cross-sectional view of the shape of the removable lid that is snap fit to the module cover;

FIG. **6** is a front view of a module case held in alignment at the four corners thereof by the chassis guide rail structure;

FIG. **7** is a partial sectional view of a pull-tab hinged to the front cover of the module case;

FIG. **8** is a back view of the front cover of a module case of FIG. **4**, with the hinged pull-tap removed;

FIG. **9** is an isometric view of a three-board circuit assembly housed by the module case, and where the socket connector thereof is connectable to a multi-pin backplane assembly;

FIG. **10** is a drawing showing the three circuit boards of FIG. **9** and associated socket connector shown in exploded form;

FIG. **11** is an enlarged and partial cross-sectional view of a printed circuit board with the miniature socket pins soldered thereto and maintained aligned by an apertured spacer board;

FIG. **12** is a partial cross-sectional top view showing three of the circuit boards of FIG. **11**;

FIG. **13** is a side view of a printed circuit board showing the miniature socket contacts, the spacer board and an apertured faceplate;

FIG. **14** is a sectional view of the interconnectivity of a module case to a backplane, and the backplane to a corresponding connector apparatus;

FIG. **15** is a partial frontal view of a chassis slot opening with a protective blank faceplate snap locked therein;

FIG. **16** is a partial sectional view, taken along line **16—16** of FIG. **15**, showing the snap lock engagement and an enlargement thereof, of the blank faceplate;

FIG. **17** is a perspective view of a portion of the chassis bezel illustrating the cut-out area;

FIG. **18** is an exploded view of another embodiment of the blank faceplate, with a spring loaded cover member hinged thereto, to provide a cover for an opening of an adjacent module slot; and

FIG. **19** is a partial sectional view of the hinged cover and blank faceplate of FIG. **17**, with the cover shown in broken lines hinged to an out-of-way position.

DETAILED DESCRIPTION OF THE INVENTION

With reference now to the drawings, there is shown in FIG. **1** the chassis assembly **10** electrically connected by an electrical cable **12** to a personal computer **14**. In the preferred embodiment of the invention, the chassis assembly **10** functions as a hard disk drive replacement for the personal computer **14**. As such, the chassis assembly **10** includes a number of modules, one being a controller module **16**, and others being hard disk drive modules, such as **18** and **20**. The other modules populating the chassis **15** may be yet other hard disk drive modules, or other circuit board assemblies having circuits mounted thereto for carrying out particular functions. In the preferred embodiment, the hard disk drive module **18** functions as a main hard disk drive, while the disk drive module **20** serves as a mirror disk drive to mirror or back up the data written to the main disk drive **18**. When embodied in the illustrated form, either the main or mirror hard drives are removable by the computer user. This portability and compactness of the units facilitates the archival storage of data, or simply the portability of a large amount of data from an office computer to a home computer. The controller module **16** functions to communicate with the personal computer **14** via the cable **12** which includes a small computer system interface (SCSI) bus for communicating disk drive commands between the personal computer **14** and the controller module **16**. The controller module **16** includes a digital signal processor that is programmed to provide a continuous backup of data to the mirror disk drive **20**.

The chassis **15** of the assembly includes optional support stands **22** for supporting the chassis **15** at a slight angle above a desk or table top. The support stands **22** are fastened to the sides of the chassis **15** by way of small screws. Each module, such as module **16**, is removable from the chassis **15** by way of a hinged pull-tab **24** for easy removal and replacement of the module with respect to the chassis **15**.

While the foregoing illustrates the invention employed as a hard disk drive replacement for a personal computer **14**.

the invention is not limited to such an application. The modules **16** can house any type of electrical circuits or components to provide any function whatsoever as a stand-alone unit, or for operation in conjunction with a host or slave system. Moreover, the general configuration of the chassis assembly **10** can be other than that shown in the drawings, such as being dimensioned to accommodate more modules or different sized modules, or be integrated within other electrical hardware, such as within the personal computer **14** itself. Further, the chassis assembly **10** can be further adapted for being rack mounted in a bay of other electrical equipment.

With reference to FIG. **2**, there is shown the basic component parts of the chassis assembly **10** according to the preferred embodiment of the invention. A replaceable module **18** is shown in isometric form, as it is about to be inserted into the chassis **15**. The components of the chassis **15** include a top panel **30**, a bottom panel **32** and two side panels **34** and **36**. The various panels of the chassis **15** are constructed of aluminum, machined to form the various shapes. More particularly, a number of machined guide rails, such as shown by reference character **38** are machined into the bottom chassis panel **32** to provide registration of the module **18** therein. Similarly, a number of guide rails **40** are machined into the top chassis panel **30** to provide a similar function with respect to the module **18**. The engagement of each guide rail **38** or **40** with a surface of the module **18** provides both a precise vertical and horizontal registration of the module **18** within the chassis **15**. The details of the accurate alignment or registration of the module **18** within the chassis **15** are described in more detail below.

A number of holes are drilled in the top and bottom chassis panels **30** and **32** for insertion therein of corresponding steel split pins **42**. Each side panel has corresponding holes or slots **44** formed therein to receive an associated split pin **42**. The split pins **42** fit within the respective holes of the top and bottom panels **30** and **32**, as well as the side panels **34** and **36** by a compression clearance fit. With this arrangement, a rigid and easily constructed chassis is provided. In a similar manner, a decorative bezel **46** is fastened to the front edge opening of the chassis by way of the split pins and holes described above. The front bezel **46** does not provide any accurate alignment function of the module **18** with respect to the chassis **15**.

Mounted to the back of the top, bottom and side panels of the chassis are two boards **50** and **52** which form a backplane for the interconnectivity of the various modules **16–20**. The spacer board **50** is appropriately populated with a number of miniature pin contacts **54** corresponding to the position of miniature socket contacts of the module **18**. The spacer board **50**, according to the preferred embodiment of the invention is about 5⅛ inches wide, 3⅜16 inches high, includes room for six vertical rows of holes, with sixty-two holes per vertical row, totaling three hundred and seventy-two possible contact positions per module slot. However, and as noted above, the holes in the board **50** are only populated with miniature pin contacts to the extent required by each module **18**. The spacer board **50** essentially holds or spatially supports the miniature pin contacts both vertically and horizontally from neighboring pin contacts by a distance of about 0.05 inches. The spacer board **50** is a jig that essentially holds the miniature pin contacts in the particular spaced configuration. Each pin contact **54** extends through the spacer board **50** and into the backplane board **52**, which is a multi-layer type of printed circuit board. The pin contacts are soldered to the appropriate conductor pads on the back side of the backplane printed circuit board **52**. In practice, the spacer board **50** is held flush against the backplane printed circuit board **52**. The backplane printed circuit board **52** includes the various conductor lines forming busses between the modules, as well as to the controller module **16**. The bus interface boards **50** and **52** are accurately aligned to the back of the chassis **15**, and fastened thereto by a number of screws (not shown) that pass through accurately-located holes in the boards **50** and **52** with respect to corresponding threaded holes in the back edges of the upper and lower chassis panels **30** and **32**. Thus, when the module **18** is inserted between the upper and lower guide rails **40** and **38**, the miniature socket contacts at the back of each module **18** are pushed onto the corresponding miniature pin contacts **54** fixed to the bus backplane boards **50** and **52**. The friction fit between the miniature sockets and pins provide the mechanism for maintaining the modules locked within the chassis **15**.

A user interface board **56** is electrically connected to the bus backplane board **52** by way of additional pin and socket contacts (not shown in FIG. **2**). The user interface board **56** includes a number of connectors to which connectorized cables can be attached for coupling the chassis assembly **10** to other equipment, such as the personal computer **14** shown in FIG. **1**. A protective metal back plate **58** includes various rectangular openings (not shown) for allowing the connectors of the user interface **56** to protrude thereto. Also not shown, the metal back plate **58** is fastened to the back surface of the chassis panels by way of screws (not shown). An insulator film or board (not shown) is installed between the user interface **56** and the metal back plate **58** to prevent short circuiting therebetween. The various features of the backplane and user interface will be described in more detail below.

With reference to FIG. **3**, there is illustrated the features of a module **18** adapted for housing a modular hard disk drive unit **60**. Hard disk drives identified by model MK1926FCV, commercially obtainable from Toshiba Corporation, or similar-size drives, are well adapted for use with the invention. The hard disk drive of such type has a length of about 4 inches, a height of about 2.75 inches and a thickness of about 0.5 inch, and can store about 814 megabytes of data. Hard disk drive units of similar physical size and capable of storing about 1300 megabytes are also commercially available. Hard disk drives having thicknesses of about 0.75 inches are available for storing about 2.16 gigabytes of data. Hard disk drives of other physical dimensions and data storage capacities can be readily adapted for use with the invention. The disk drive unit **60** is insertable within the module case **18** via a removable lid, such as shown in FIG. **4A**, so as to be securely held therein. In order to facilitate the transfer of heat away from the disk drive unit **60**, a metallic side cover of the unit is engaged against the inside surface of the removable lid to thereby transfer heat generated within the unit **60** to the chassis **15** via the module case. A reliable engagement between the disk drive unit **60** and the internal surfaces of the module case can be assured by using insulator foam or other resilient material on one side or edge of the unit **60** to maintain engagement with the other side or edge to the metallic module case. The resilient material can also reduce shock to the disk drive unit **60** due to impact of either the case **18** or the chassis **15**. Indeed, the resilient material itself can be of a type having a high thermal transfer characteristic.

The disk drive unit **60** includes a number of pin contacts **62** adjacent the back edge thereof for communicating read, write, data and address signals to the unit **60**. The disk drive unit **60** is electrically connected to a miniature socket

contact collector assembly **64** which is fastened to the back opening of the module case **18**. The socket contact collector **64** is constructed of a fiberglass insulator for supporting a number of miniature socket contacts at spaced apart locations identical to that of the miniature pin contacts in the backplane board **52** (FIG. **2**). An interconnect circuit assembly **66** provides circuit connections between the pins **62** of the hard disk drive unit **60** and the socket contact collector **64**. The interconnect circuit assembly **66** includes a socket contact connector **68** adapted for mating with the pins **62** of the disk drive unit **60**. A flexible, multi-conductor cable **70** provides a number of conductors between the connector **68** and a small printed circuit board **72**. The printed circuit board **72** is of the multi-layer type providing high density connection between the socket contacts of the collector **64** and various integrated circuits shown by reference numeral **74**. Moreover, various miniature socket contacts supported by the collector **64** are routed via the printed circuit board **72** to the flexible cable **70**, and therethrough to the disk drive unit **60**, via the connector **68** and corresponding pins **62**. While not shown, a number of socket contacts are soldered directly to the back side of the printed circuit board **72**, with the open end thereof protruding outwardly orthogonal thereto. A small insulator spacer with multiple apertures therein is slipped over the tubular-shaped socket contacts and provides a spacing between the back side of the printed circuit board **72** and the socket contact collector **64**. The spacer prevents the open ends of the socket contacts from protruding all the way through the insulator collector **64**. The socket collector **64** is not fastened to either the printed circuit board **72** or the miniature socket contacts, but rather has a number of holes therein for allowing the miniature socket contacts to be snugly housed therein and protected from physical exposure. As noted above, the open ends of the socket contacts are recessed a few thousandths of an inch within respective holes of the collector **64** and are therefore accessible for insertion therein of the rounded ends of the pins **54** of the backplane board **50** (FIG. **2**). The collector **64** is shown in more detail in FIG. **4A**. It is noted that the socket collector **64** includes many holes for housing miniature socket contacts. However, it is necessary only to utilize as many holes as required by the circuit module to provide the requisite number of conductors. Indeed, in the preferred form of the invention, the standard disk drive unit **60** identified above requires only about thirty-five conductors, and thus thirty-five miniature socket contacts are utilized.

With reference again to FIG. **3** again, it is noted that the interconnect circuit assembly **66** is not rigidly mounted to the disk drive unit **60**, but rather is flexible due to the flexible cable **70**. The flexible cable also functions as a resilient member for maintaining the unit **60** pushed against the frontal inside surface of the module faceplate. As such, the flexible cable **70** acts like a shock absorber. In a preferred form of the invention, the integrated circuits **74** comprise a number of latches controlled by the controller module **16**, for latching address, data and control signals for use by the disk drive unit **60**. Preferably, the address and control signals are coupled unidirectionally from the controller module **16** to the disk drive unit **60**, via the respective latches **74**, while the data is coupled bi-directionally, via data transceivers **74**, between the disk drive unit **60** and the controller **16**.

It is to be noted that the disk drive module **18** shown in FIG. **3** is entirely removable from the chassis assembly **10**, as well as reinsertable. In this manner, data can be removed as a package from the chassis assembly **10** and maintained safe by the user, can be stored for archival purposes, or can be transported from an office computer to a home computer. It can be appreciated that the user accessability to removable disk drive units substantially enhances the flexibility of data storage, retrieval, security and repair of the unit.

With regard to FIG. **4***a*, there is illustrated the mechanical features of the module case shown by reference character **16** in FIG. **1**. The components of the module case shown in FIG. **4A** are held together by four long screws, with the exception of the snap-fit lid **88** described below. The module case **16** is similar in construction to the other modules **18–20** shown in FIG. **1**, with the exception of the faceplate and the number and types of components fastened thereto, and the removable lid of the disk drive modules **18** and **20** do not have a window or opening formed therein. In the preferred form of the invention the module case **16** includes a three-sided integral protective cover **80** having a top side **82**, a bottom side **84** and a vertical fixed side **86**. A snap-fit lid **88** is removably attached to the module cover **80** by the utilization of contoured surfaces and edges more particularly shown in FIGS. **5A** and **5B**. The module cover **80** and the removable lid **88** are machined from an aluminum material and thereafter anodized to prevent oxidation as well as to facilitate insertion of the module into the chassis **15**, via the upper and lower guide rails **40** and **38**. A faceplate **90** of the module is also constructed of aluminum and thereafter anodized. The socket collector **64** is constructed of an insulator material, such as fiberglass or plastic. The fixed side **86** of the module cover **80** includes on the rear inside surface thereof a stop **92** that protrudes inwardly from the module case. The stop **92** engages against a recessed area **94** on the insulator collector **64**. In this manner, external pressure on the middle portion of the insulator collector **64** prevents bowing thereof toward the internal part of the module. This enhances the rigidity of the insulator contact collector **64**, especially when a large number of miniature sockets of the module and pin contacts of the chassis are engaged together.

Formed also on the internal surface of the fixed side **86** of the module cover **80**, near the frontal edge thereof, is a similar stop **96** that engages with a recessed area (not shown) formed on the back side of the faceplate **90**. The recessed area of the faceplate **90** abuts against the stop **96** and prevents the faceplate from bending inwardly when external pressure is applied to the module case **16** when inserted into the chassis **15**. The insulator collector **64** includes a recessed peripheral edge **98** therearound on the internal edge thereof for fitting therein of the back edge of the module cover **80** and the removable lid **88**. While not shown, the back peripheral edge of the faceplate **90** is similarly recessed so as to be fittable to the frontal edge **100** of the module cover **80** and the frontal edge **102** of the removable lid **88**.

The insulator collector **64** and the faceplate **90** are not directly fastened to the module cover **80**, but rather are fastened to each other by way of four elongate screw fasteners, one of which is shown by numeral **104**. The elongate fasteners **104** include threads **106** at one end thereof, for threadable engagement into corresponding threaded holes formed on the back side of the faceplate **90**, shown more particularly in FIG. **7**. The elongate fastener **104** includes a head **108** shown in more detail in FIG. **4B**, together with the engagement thereof to the insulator collector **64**. The head **108** of the fastener **104** is larger in diameter than the shaft and includes a diametric thinned portion **110** for grabbing with a tool to rotate the fastener **104**. The insulator collector **64** includes a first bore **112** of a diameter for accommodating the shaft of the fastener **104**, and a second, larger bore **114** of a diameter for accommodating the head **108** of the fastener **104**. In practice, when the assembly of the module case **16** is completed, the head **108** of the fastener **104** is recessed and hidden entirely within the larger-diameter bore **114** of the insulator collector **64**. As can be appreciated, when the four elongate fasteners **104** are inserted through the corresponding corner holes in the

contact collector 64, and threaded into the corresponding holes of the faceplate 90, the collector 64 and the faceplate 90 are pulled together, with the three-sided module cover 80 compressed therebetween. The removable lid 88 is slightly shorter in length than the cover 18, and thus not compressed between the contact collector 64 and the faceplate 90. In certain instances or applications, it may be advantageous to fully assembly the electrical circuits within the case 16 and then securely fix the lid 88 thereto by a suitable adhesive. With this construction, the electrical components are not easily accessible.

The module case 16 shown in FIG. 4A comprises a controller module that houses a digital signal processor and associated circuits mounted on three multi-layer printed circuit boards. The faceplate 90 includes small holes 120 and 122 for holding respectively a read led and a write led. Larger holes 124 and 126 hold respectively a push-type controller reset switch and an optional switch. The indicator leads and switches are mounted to the internal printed circuit boards, but protrude through holes in the faceplate 90. Hingably fastened to the faceplate 90 is a pull-tab 24 shown in more detail in FIG. 7.

With regard to FIG. 5A of the drawings, there is shown the module case 80 that encloses three printed circuit boards, one of which is identified by reference numeral 130. The module case 80 includes the three-sided cover 86 and the removable lid 88. Formed on the internal four corners of the module case 80 are elongate shoulders 132 for centering therebetween upper and lower guides 131 that are slotted for sliding therein the printed circuit boards. The upper and lower guides 131 includes elongate slots formed therein to receive the upper and lower edges of the printed circuit boards. The guides 131 can be constructed of an insulating material such as fiberglass, or with an adhesive-backed foam material that is adhered to the edges of the printed circuit boards. The foam material can be preformed to provide channels for separation of the boards 130, as well as to provide insulation between the components or conductor paths and the elongate shoulders 132 of the module case 16. Additional wrap-around insulating tape or films can be employed to provide electrical insulation between the electrical components and the conductive module case. While not shown in FIG. 5A, there are preferably additional socket-pin connections between the center printed circuit board and the outer boards, thereby providing electrical paths therebetween as well as physical separation.

The guides 131 are first inserted over the upper and lower edges of the plural circuit boards, and the assembly is then slid into the module case 80 via the open back end thereof. It can be appreciated that the guides 131 prevent the conductors and components mounted on the printed circuit boards from short circuiting either between the boards or to the metal case 80. In this manner, the conductor pads and lines on the outside surfaces of the printed circuit boards 130 are maintained spaced from the elongate fasteners 104, thereby preventing short circuits therebetween. Of course, the printed circuit boards 130 are designed so as not to have any conductor pads or components near the surface edges that engage the elongate shoulders 132 or the case.

The removable lid 88 of the module case 16 includes elongate edge configurations 134 that snap lock with special shaped edges of the module top cover 82 and module bottom cover 84. The upper and lower engaging surfaces between the removable lid 88 and the module cover edges are identical, one being shown enlarged in FIG. 5B. The edge of the cover top 82 is machined with a downwardly depending rounded edge 136. The rounded edge 136 tapers inwardly to the internal surface. The tapered surface 137 facilitates removal of the lid 88 from the three-sided cover 80. The outer face edge 138 of the cover top 82 is flat and formed orthogonal to the top surface.

The removable lid 88 includes an elongate channel receptacle formed with a rounded trough 140 to receive therein the rounded edge 136 of a cover edge. When the removable lid 88 is pushed onto the module cover 80, the elongate rounded edge 136 of the cover top 82 engages within the machined receptacle trough 140 of the lid 88 and is mechanically snap locked therein. When snap-locked together, an internal vertical surface 142 of the removable lid 88 engages against the corresponding outer flat surface 138 of the cover top 82. The engagement between the surfaces 138 and 142 is important in maintaining a precise lateral dimension to the overall module 16 so as to be accurately aligned within the guide rails 38 and 40 of the chassis 15, as shown more fully in FIG. 6. The snap-fit structure of the top side 82, the bottom side 84 and the top and bottom edges of the lid 88 are identical.

In order to remove the lid 88, a screwdriver or other similar object is forced between the edges 138 and 142 to thereby pry the parts apart. Because the channel receptacle 140 is cupped, one of either the engaging rounded edge 136 or the side cover 88 must distort slightly in a vertical direction to become disengaged. In practice, the removal of the engaged parts bows the side cover 88 slightly outwardly to allow disengagement between the rounded cover edge 136 and the channel receptacle 140 of the lid 88. This is important in preventing the side cover 88 from becoming inadvertently removed due to pressures exerted on the module, metallic contraction due to temperature changes, etc. Moreover, the anodized surface finish of the metallic parts functions somewhat as a lubricant to facilitate the removal of the metallic parts.

With reference now to FIG. 6, there is illustrated the manner in which the module 16 is accurately aligned within the chassis 15, so that the module miniature socket contacts and backplane pin contacts 54 remain aligned and can be forcefully engaged without bending of the miniature pins. As noted above, each corner of the module 16 includes a 45° bevel or chamfer, one shown as reference character 150. In practice, the diagonal dimension of the bevel as shown in FIG. 6 is about 0.125 inches and extends longitudinally along the entire length of the four corners of the module 16.

Machined on both the chassis top panel 30 and the chassis bottom panel 32 are spaced apart guide rails 40 and 38. The guide rails 40 and 38 extend generally orthogonal from the inside surface of the chassis top panel 30 and the chassis bottom panel 32. However, the cross-sectional shape of the guide rails is generally rounded so that a curved portion of the rail engages with a corresponding corner bevel 150 of the module 16. With this arrangement, very little sliding or frictional contact exists between the bevel surface 150 of the module 16 and the rounded guide rails 40, thereby minimizing friction. The specific shape of the contact edges of the guide rails 38 and 40 can be other shapes, such as square or triangular corners, etc. Further, the guide rails 38 and 40 are constructed of anodized aluminum, as is the module cover 80 thereby reducing the sliding friction. More importantly, the four corner contact surfaces 150 of the module with the respective guide rails 38 and 40 provides both a vertical and horizontal registration, to thereby ensure a highly accurate alignment of the module 16 within the chassis 15. This, in turn, assures a very accurate alignment between the module socket contacts and the chassis back plate pin contacts 54. This guide rail module contact configuration differs from the prior art structures which are either vertical or horizontal surfaces that provide either a vertical or horizontal placement of the module within the chassis, but not both. As noted above, despite that the lid 88 is removable, the bevel surfaces 152 (FIG. 5B) do not interfere with the accuracy of alignment, as the machined vertical surfaces 138 and 142 assure the lateral dimensional

consistency of the spacing between the top corner bevels and the bottom corner bevels of the module case **16**. The registration tolerance between the module case **16** and the chassis **15** can be maintained within about +0.002 inches. In view that a miniature contact pin **54** (FIG. **2**) of the chassis backplane has a rounded end and a diameter of about 0.016 inches, the insertability thereof into a corresponding socket contact is assured to a high degree of accuracy.

The hinged pull tab **24** shown in FIG. **6** includes two slightly recessed face areas **154** for applying thereto a decal or sticker bearing identification or other indicia of the module. The construction of the hinged pull tab **24** is shown in more detail in FIG. **7**. The faceplate **90** includes an opening **156** therein for the pull tab **24**. The pull tab **24** includes a channel formed laterally on the inside face of the faceplate **90**, in which a pin **158** is adhered by a suitable adhesive. The protruding ends of the pin **158** loosely fit within corresponding channels **160** (FIG. **8**) of the inside surface of the faceplate **90**. When the faceplate **90** is fastened to the frontal edge of the module case **16** with the long screws **104**, the ends of the hinge pin **158** are captured between the module case edges and the faceplate channels **160**. With this construction, the pull tab **24** can be hinged outwardly and pulled, thereby forcefully removing the module **16** from the chassis **15**. Importantly, the bottom of the pull tab **24** does not become recessed entirely within the window **156** of the faceplate, as is the top portion of the pull tab **24**. Rather, the bottom portion of the pull tab **24** remains hinged slightly outwardly at the bottom thereof as shown in FIG. **4A** to thereby allow a user to easily grasp the pull tab **24** and pivot it further outwardly for firm grasping. Formed on the inside corner of each of the four inside corners of the faceplate **90** is an ear **162** having a threaded hole for securement therein of the elongate fastener **104**. Further, the ear **162** is located to function as a stop so that the bottom of the pull tab **24** cannot be hinged fully inside the window **156**, but rather remains slightly pivoted outwardly, as noted above.

FIG. **8** shows the general construction of the features formed on the inside surface of the faceplate. Shown are the recessed areas **164** that abut against the cover side stops **96**, shown in FIG. **4A**. Also shown is the inner recessed peripheral edge **166** which accommodates therein the frontal edge of the module cover **80** as well as the frontal edge of the removable lid **88**.

FIG. **9** illustrates in more detail the association between the module case **16** and the apparatus housed thereby, in conjunction with the various backplane boards. Also shown in detail is the printed circuit board **130** having various integrated circuits mounted thereto, including a replaceable erasable programmable read only memory (EPROM) **170**. The removable lid **88** of the module case **16** includes a window **171** that is aligned with the EPROM **170**, when fully inserted into the socket **172**. The EPROM chip can have adhesively attached thereto a label **173** which has identifying indicia printed thereon. In this manner, the EPROM **170** can be removed and replaced with a new programmed chip, without removing the printed circuit board **130** from the module case **16**, and without removing the removable lid **88**. This allows easy update of the software programming of the processor housed in the control module **16**.

Also shown in FIG. **9** is the manner in which the user interface board **56** is electrically connected to the backplane bus board **52**, via a plurality of socket and pin contacts **174**. Various connectors can be fastened to the user interface board **56**, and particular to the conductor paths formed on the opposite side of the board shown in FIG. **9**. For example, a connector **176** can be provided for coupling various supply voltages and ground potentials between the chassis assembly **10** and the personal computer **14**. Another connector **178** can be utilized for providing SCSI bus connections between the computer and the chassis assembly **10**. Lastly, an optional third connector (not shown) can be utilized for connection to an uninterruptable power supply. Many other varieties, numbers and types of connectors can be utilized to accommodate the particular application to which the invention may be employed. In accordance with an important feature of the invention, the user interface board **56** is removable from the backplane **52** by way of the pin-socket connections **174**. With this arrangement, different user interface boards **56** can be employed to accommodate different user applications, all without requiring a different chassis **15** or a backplane **52**. Other types of user interface boards **56** electrically pluggable to the backplane **52** can employ multiple user ports or connectors, different power supply arrangements, and different types of bus connectors **178**, other than the SCSI bus noted above. The versatility and utilization of different user interface boards **56** greatly facilitates the inventory and assembly of module and chassis assemblies that perform different functions. For example, in assembly line construction of the invention, the same chassis, modules and backplane **52** can be assembled together, but with different user interface boards to custom tailor the interface to the particular user needs.

In addition to the foregoing, different backplane boards **52** can be utilized to provide different interconnections to the modules, as well as different connections to the user interface board **56**. An inventory of different backplanes allows the use of the same chassis and many of the modules, but interconnects them differently to carry out different functions. Indeed, instead of a single processor or controller module, two different controllers can be utilized, interconnected by a different backplane, to carry out multitasking or other functions. Where additional data storage capacity or higher speed access thereto is needed, additional chassis slots can be populated with hard disk drive modules. The utilization of parallel-operated hard disk drives is significantly more advantageous, especially in terms of reliability, than the use of high RPM hard disk drives that increase the access speed to any of the data stored thereon. Should different software be required to operate with a different user interface board **56**, then a different EPROM can be utilized by the simple removal of the processor module **16**, and the exchange of the existing EPROM with a newly programmed EPROM **170**.

The three printed circuit boards **130***a–c* of the controller module **16** are shown in FIG. **10**, as they relate to the socket contact controller **64**. As noted with regard to the printed circuit board **130***a*, there is shown a set of metallic contact pads **182**. Indeed, such contact pads appear on both sides of the rear edge of the printed circuit board **130***a*. In like manner, the other two printed circuit boards **130***b* and **130***c* also include similar pads for soldering thereto the miniature socket contacts. Each printed circuit board **130***a–c* may or may not be fully utilized with regard to all contact pads **182**. There can be formed a maximum of about six vertical rows of contacts on the three printed circuit boards, which, when assembled together, are aligned with the corresponding six vertical rows of holes **184** in the socket contact collector **64**, which in the preferred from, is only about one-half inch wide. As can be seen in FIG. **5***a*, there is additional space for two additional printed circuit boards, which are preferably shorter in height so as not to interfere with the inside corner structures of the module case **16**. When five printed circuit boards are employed, a total of ten parallel rows of contacts are available, providing a sufficient number of electrical connections to accommodate a 512-bit bus and control signals.

FIGS. **11–13** illustrate the details of the high density contacts for providing a large number of separate electrical

signals to compact printed board circuitry housed within a module case. In FIG. 11, there is illustrated a printed circuit board 130*a* as viewed from the top. Each hole 184 drilled in the fiberglass socket collector 64 includes a small annular chamfer (not shown) at the entrance end thereof. This helps in centering the socket contacts 190 for insertion into the collector plate holes 184.

FIG. 12 illustrates a top sectional view of the three printed circuit boards, and FIG. 13 shows a side view of the center printed circuit board 130*b*, with a spacer 192 to limit the extent by which the module socket contacts 190 enter into the holes 184 of the collector 64. Three such printed circuit boards 130*a–c* are shown held in a close spaced-apart relationship at the rear end thereof by the socket contact collector 64. As noted above, the grooved tracks formed in the top and bottom insulator board guides 131 maintain the elongate edges of the printed circuit boards spaced apart. With specific reference to FIG. 11, and 13, miniature socket contacts 190 are soldered or otherwise electrically fixed to the conductor pads 182 formed adjacent the rear edge of the board. The enlarged barrel of the socket contact 190 includes an internal spring contact (not shown) for providing a high quality electrical connection to a pin contact 54 when inserted therein. The socket and pin contacts are of conventional design and readily available.

In the assembly of the printed circuit boards 130 and corresponding socket contacts 190, an insulator spacer 192 is utilized on the two rows of contacts 190 of the middle printed circuit board 130*b* for limiting the entry of all six rows of socket contacts 190 within the collector 64. Importantly, the spacer 192 prevents the socket-contacts 190 from protruding all the way through the socket collector 64. The spaced relationship between the socket contacts 190, both vertically and laterally correspond identically to the spacing of the holes 184 of the socket collector 64 shown in FIG. 13. Only one spacer 192 having two vertical rows of holes is necessary, although a wider spacer could be utilized to accommodate all six rows of socket contacts on the three printed circuit boards. The holes in the spacer 192 are sized so as to loosely surround the respective socket contacts 190. During assembly, a socket collector jig (not shown) is populated with the requisite number of socket contacts 190, which are firmly held therein, depending upon the need therefor to provide sufficient I/O signals to two rows of solder pads 182. When the collector jig is appropriately populated with socket contacts 190, such contacts are held against the respective solder pads 182 on both sides of the board 130*a*, as shown in FIG. 11. Once the printed circuit board 130*a* is fixed with respect to the spacer 192, the socket contacts 190 are either individually or collectively soldered as a group to the respective pads 182. Thereafter, the collector jig is removed from the socket contacts 190, whereupon such contacts remain spatially aligned and separated by virtue of being rigidly fixed to the printed circuit board 130*a*. In FIG. 13, the spacer 192 is shown in association with the socket contacts 190 of the middle printed circuit board 130*b*. Also shown in FIG. 13 is a cross-sectional view of the socket collector 64, as well as an end view thereof. The next step of the assembly is the insertion of the individual printed circuit boards 130*a–130c*, and particularly the socket contacts 190 thereof into the holes 184 formed in the socket collector 64. Each printed circuit board can be separately mounted in such manner, whereby the socket collector 64 provides a fixed and spaced-apart relationship between both the socket contacts 190 themselves, as well as a spaced relationship of the back vertical edges of the printed circuit boards 130*a–130c*.

FIG. 14 illustrates a partial sectional view of the electrical connections between one printed circuit board 130*a*, the backplane boards 50 and 52 and the user interface board 56. The general purpose of the insulator board 50 is to hold the pin contacts 54 in a specific spacial relationship so as to be mateable as a unit with the module socket contacts 190. As shown, the miniature pin contacts 54 soldered within the backplane boards 50 and 52 provide an electrical connection to the miniature socket contacts 190 that are part of the insertable module. While not shown, numerous conductor pads are formed on the backplane board 52, in contact with selected ones of the miniature contact pins 50. Moreover, additional socket contacts 196 are soldered to the backplane boards 50 and 52 to provide power and signals thereto. The socket contacts 196 may be physically larger than the miniature socket contacts 190 to handle the requisite electrical power or supply voltage. Corresponding pin contacts 198 are soldered to the user interface board 56, which pins are mateable with the sockets 196 to provide electrical connections between the user interface board 56 and the backplane boards 50 and 52. While not shown, the various connectors 176 and 178 in FIG. 9 are soldered to the various conductors of the user interface board 56. As such, supply voltages and electrical signals can be communicated between the personal computer 14 and the chassis assembly 10. As noted above, different types of user interface boards 56 are pluggable into the backplane 52 for accommodating different applications required by the user. In like manner, different backplane boards 50 and 52 can be used with the chassis 15 to accommodate different connections between the various modules. For example, when some of the modules utilized are for mass memory storage, such as hard disk drives, FLASH EPROM, ferroelectric memories, etc., such memory modules can be connected in series or in parallel by way of different backplane boards 50 and 52. When employing hard disk drives, the bandwidth of the system can be increased by operating the drives in parallel with one type of backplane 52, without requiring higher rotating speeds of the disk drives. In view of the foregoing, many different user applications can be accommodated by the utilization of different backplanes and different user interface boards, each of which is pluggable to each other, and easily assembled with the chassis 15.

FIGS. 15 and 16 depict a blank faceplate 200 that can be utilized with the chassis 15 for covering unused module slots. The blank faceplate 200 is constructed for snap locking to the bezel 46 of the chassis 15 to thereby provide easy removal or installation of the faceplate. The blank faceplate 200 enhances the aesthetic appearance of the chassis 15, as well as prevents dust and other airborne particles from easily entering the internal portion of the chassis. The blank faceplate 200 is preferably constructed, such as by machining or molding, of the same material as the chassis 15, and then painted, anodized or otherwise colored to match that of the chassis 15.

The blank faceplate 200 includes top and bottom edges having snap-lock members that engage with corresponding members machined into the bezel 46. The snap-lock engaging members formed at the top and bottom of the blank faceplate 200 are essentially identical, one being shown enlarged in FIG. 16. The bezel 46 includes a cupped or cut-out portion 202 formed laterally along the entire width of the slot opening, as shown in FIG. 17. The same type of cut-out area 202 is formed in the top portion of the bezel 46. Although the cut-out portion 202 is shown generally rectangular in shape, it can be formed with many other shapes, such as concave, oval, round, triangular, etc. At the bottom edge of the blank faceplate 200, a complementary-shaped lip 204 is formed. The lip 204 projects a small distance beyond the visible lower edge 206 of the blank faceplate 200. The lip 204 is preferably not formed along the entire top and bottom edge of the blank faceplate 200, but rather along only a portion thereof, such as between the beveled corners of the faceplate. Alternatively, the lip 204 can comprise several

short lips or individual projections for fitting into corresponding-shaped depressions formed in the bezel **46**. In the preferred embodiment of the invention, the extent by which the lip **204** extends beyond the bottom edge **206** is about 0.020 inch, and the depth of the lip **204**, as shown in the enlarged portion of FIG. **16**, is about 0.030 inch. Those skilled in the art may find that rounding the corners of the lip **204** facilitates the installation or removal of the blank faceplate **200** from its snap-lock engagement with the chassis bezel **46**. In some instances, it may be preferable to form the snap-lock projection on the bezel **46**, and form the cupped area in the edge of the blank faceplate **200**.

The installation is accomplished by first engaging the lower lip **204** into the cut-out portion **202** of the lower bezel **46** and then firmly pushing in the top of the blank faceplate **200** to thereby forcefully cause engagement of the upper lip and corresponding cut-out area. Although the blank faceplate **200** is not shown equipped with a hinged pull tab, such a structure could additionally be employed to easily remove the blank faceplate **200** from the chassis **15**. The faceplate **200** can otherwise be removed by removing a module from an occupied adjacent slot, and reaching therein and pushing from the backside of the blank faceplate **200** to disengage either the top or bottom snap-lock structures.

With regard to FIGS. **18** and **19**, there is shown additional structure fastened to the blank faceplate **200** for providing a hinged cover to an adjacent unoccupied module slot, as shown in FIG. **19**. The cover **210** is hinged with a spring-loaded arrangement to the blank faceplate **200**. A planar bracket member **212** is fastened or formed integral with the blank faceplate **200**. The bracket member **212** includes two slotted openings **214** formed in the rear vertical edge thereof with corresponding holes **216** formed therein for insertion of respective compression-fit pins **218**.

The cover **210** includes a pair of right-angle arms **220** fastened thereto or formed integral therewith, each arm being thinner than the height of the corresponding slotted opening **214** formed in the bracket **212**. Each arm **220** includes a small hole **222** therein for engagement with the down-turned end **224** of a spring **226**. Both the spring **226** and the angle arm **220** are fitted within the slotted opening **214** of the faceplate bracket **212**. The pin **218** is then inserted through both the opening formed by the coils of the spring **226**, as well as through the hole **228** formed near the end of the angle arm **220**.

The assembled arrangement of one hinged, spring-loaded structure is shown in more detail in FIG. **19**. The hinged cover **210** can be pivoted to the position shown in broken line in FIG. **19**, whereby the spring **226** attempts to force the hinged cover **210** in the direction shown by arrow **230**. The hinged cover **210** can be manually pivoted as shown in FIG. **19** for easy insertion of the blank faceplate **200** into an unoccupied module slot. After snap-locking the blank faceplate **200** into the bezel **46**, as described above in connection with FIGS. **15–17**, the cover **210** will be spring biased to the position shown in solid line, thereby providing a cover to an adjacent unoccupied module opening. In the event that a module is inserted in the otherwise blank opening, the cover **210** is automatically pushed backwardly out of the way by the insertion of the module into the slot. The hinged cover **210** is thus moved out of the path of entry of the module, into the unoccupied module area covered by the blank faceplate **200**. When the inserted module is removed, the spring-loaded cover **210** returns to its position covering the module opening in the chassis. While not shown, various stop members may be constructed on either the arm **220** or the cover **210** itself so that the cover **210** does not pivot outwardly beyond the module slot opening.

FIG. **19** illustrates the guide rails **38** with a portion thereof removed so that the hinged faceplate **210** can be pivoted into the space of an adjacent slot. The interruption in both the top and bottom guide rails of the chassis **15** does not otherwise affect the insertability, withdrawal or alignment of the module case **18** with respect to the backplane pin contacts **54**. In order to shorten the length by which the guide rails **38** are removed to accommodate the passage of the hinged faceplate **210** therethrough, the frontal faceplate **210** can be hinged to the right angle arm **220** and biased with a spring so that the faceplate **210** is not orthogonal to the end of the arm **220** as shown. With this additional hinged arrangement, the interruption in the guide rails **38** can be reduced. The spring biased faceplate **210** can be mounted to the arm **220** with a planar spring-like material so that after flexing to pass through the guide rail openings, the faceplate **210** returns to its rest position as shown, orthogonal to the end of the arm **220**.

From the foregoing, described is a compact chassis assembly accommodating a substantial amount of dense circuitry in a small area. The precision machining of the various components, including the module cases and the guide rails of the chassis allow a precise positioning of the multiple socket contacts thereof with the corresponding pin contacts of the backplane. In view of the dense nature of the electrical contacts, and the relatively small dimensions thereof, accurate alignment is critical so as to prevent damage or bending of the pin contacts. Moreover, the compact design of the modules allow one side cover thereof to be easily removed for inspection or adjustment of the underlying circuit components, all without affecting the overall integrity of the module. Moreover, the size of each module case is generally about the size of a cigarette package, but nevertheless suitable for enclosing a small hard disk drive unit, or three circuit boards having dense circuits and components mounted thereto. In accordance with an important feature of the invention, each module can accommodate over **372** electrical connections thereto when employing three printed circuit boards, and over **600** pin-socket connections when employing five printed circuit boards.

From the foregoing, a much improved chassis assembly and module case have been disclosed, which structures overcome the shortcomings and disadvantages of the prior art. Further, disclosed is a technique for assembly of the structures. While the preferred embodiment of the invention has been disclosed with respect to a specific chassis and module case, it is to be understood that many changes in detail may be made as a matter of engineering choices, without departing from the spirit and scope of the invention, as defined by the appended claims.

What is claimed is:

1. A module case for housing electrical components, and adapted for insertion into a chassis having electrical contacts of one of a pin or socket type, comprising:

a rigid cover including a protective top panel, bottom panel, left side panel and right side panel, said top panel, bottom panel and one of said left or right side panels being formed as an integral one-piece unit, and said rigid cover having a frontal opening and a rear opening;

a faceplate separate from said rigid cover for providing a frontal protective cover;

a rear cover plate separate from said rigid cover for providing a rear protective cover, said rear cover plate being constructed of an electrically insulating material; and

a plurality of electrical contacts individually supported by said electrically insulating rear cover plate, said electrical contacts for providing electrical connections to components housed within said module case, and being matable with the electrical contacts associated with the chassis.

2. The module case of claim 1, wherein one said left or right side panel is constructed so as to be removable from said top panel and said bottom panel.

3. The module case of claim 2, wherein said removable panel includes substantially an entire side of said module case.

4. The module case of claim 2, wherein said removable side panel is constructed for snap fitting to said top and bottom panels.

5. The module case of claim 4, wherein said snap fit construction includes a respective tapered edge formed on said top panel and said bottom panel, and opposing side edges of said removable side panel each include a channel receptacle for receiving therein a respective said tapered edge.

6. The module case of claim 4, wherein said top and bottom panels each include a planar abutting edge, and where corresponding opposing edges of said removable side panel include corresponding planar edges for abutment when the removable panel is snap fit to said module case.

7. The module case of claim 1, wherein said faceplate includes a hingeable pull-tab for grasping thereof by a person's thumb and finger to pull said module case for removal from the chassis.

8. The module case of claim 7, further including a stop formed on said faceplate so that in a rest, non-hinged position, said pull-tab is nonparallel to said faceplate.

9. The module case of claim 1, wherein said faceplate and said rear cover plate include respective peripheral recessed portions on the edge thereof for receiving therein an edge of the rigid cover frontal opening and the edge of the rigid cover rear opening.

10. The module case of claim 1, wherein said left and right side panels each include a stop protruding from an inner surface thereof, and said faceplate and said rear cover panel have corresponding engaging surfaces engaging the stops, thereby enhancing the rigidity of the faceplate and the rear cover when attached to said rigid cover.

11. The module case of claim 1, wherein said insulator rear cover plate has a plurality of holes formed therein, each adapted for receiving therein an individual electrical contact that is connectable to electrical components.

12. The module case of claim 11, wherein each said rear cover plate hole is spaced apart in an x-y grid from adjacent holes by no more than about 0.05 inches.

13. The module case of claim 1, wherein said electrical contacts supported by said rear cover plate comprise a socket-type of contact, and each said socket-type contact is supported by way of a through hole formed in said rear cover plate.

14. The module case of claim 1, wherein said rigid cover is constructed of aluminum that is machined.

15. A module case for housing electrical components, comprising:

a rigid cover including a protective top panel, bottom panel, left side panel and right side panel, said rigid cover having a frontal opening and a rear opening;

one said left or right side panels being constructed so as to be snap fittable to said top panel and said bottom panel and thus removable therefrom;

said snap fit construction includes a respective elongate rounded edge formed on said top panel and said bottom panel, and opposing side edges of said removable side panel each include a cupped channel receptacle for receiving therein said rounded edge;

a faceplate separate from said rigid cover for providing a frontal protective cover;

a rear cover plate separate from said rigid cover for providing a rear protective cover; and

a plurality of electrical contacts supported by said rear cover plate, said electrical contacts for providing electrical connections to components housed within said module case.

16. A module case for housing electrical components and for insertion into a chassis, comprising:

a rigid cover including a protective top panel, bottom panel, left side panel and right side panel, said rigid cover having a frontal opening and a rear opening;

said rigid cover having four elongate corners, each elongate corner comprising an intersection between a side panel and one of said top or bottom panels;

each said elongate corner formed with a bevel providing a sliding contact surface with said chassis when inserted therein;

a faceplate separate from said rigid cover for providing a frontal protective cover;

a rear cover plate separate from said rigid cover for providing a rear protective cover; and

a plurality of electrical contacts supported by said rear cover plate, said electrical contacts for providing electrical connections to components housed within said module case.

17. The module case of claim 16 wherein said rigid cover includes two of said beveled corners, and wherein one said left or right side panel is removable from said top and bottom panels and said removable side panel has formed thereon two opposing elongate support areas for insertion of said module case into a chassis having four corresponding corner engaging guide rails.

18. The module case of claim 16, further including in combination a chassis having formed therein corner engaging guide rails, said guide rails having cross-sectionally round areas for engaging the respective beveled corners of said module case.

19. The module case of claim 18, wherein each chassis guide rail is elongate, and provides two elongate engaging areas for two different said module cases.

20. The module case of claim 16, further including in combination a hard disk drive housed within said module case to provide user replaceability to said hard disk drive.

21. The module case of claim 20, wherein said hard disk drive is coupled to said electrical contacts by a flexible ribbon cable.

22. The module case of claim 20, wherein said rear cover plate includes a plurality of holes, and further including a printed circuit board and at least one integrated circuit mounted thereto, and said electrical contacts are fixed to said printed circuit board and supported by respective said holes in said rear cover plate.

23. The module case of claim 22, wherein said printed circuit board is removable from said rear cover plate.

24. The module case of claim 16, further including at least one printed circuit board housed within said module case, and a programmed processor mounted thereto, a memory chip held within an integrated circuit socket mounted to said printed circuit board, and said module case includes a window opening aligned with said memory chip so that said memory chip can be replaced without removing the printed circuit board from said module case.

25. The module case of claim 16, further including plural printed circuit boards housed within said module case, each said printed circuit board having soldered thereto a plurality of said electrical contacts, and said rear cover plate is constructed as an insulator for supporting each said contact of each said printed circuit board.

26. The module case of claim 16, further including in combination a plurality of module cases, each having separate electrical components, and further including in combi-

nation a housing having guide rails for supporting each said module case at only four elongate contact surface areas, each said surface area contacting a respective said beveled corner to thereby provide a precise registration of each module within said chassis.

27. A module case for housing electrical components, comprising:

a rigid cover including a protective top panel, bottom panel, left side panel and right side panel, said rigid cover having a frontal opening and a rear opening;

a faceplate separate from said rigid cover for providing a frontal protective cover;

said faceplate including a hingeable pull-tab for grasping thereof to pull said module case, and further including a stop formed on said faceplate so that when in a rest, non-hinged position, said pull-tab is nonparallel to said faceplate;

a rear cover plate separate from said rigid cover for providing a rear protective cover; and

a plurality of electrical contacts supported by said rear cover plate, said electrical contacts for providing electrical connections to components housed within said module case.

28. The module case of claim 27 wherein said faceplate has no screw holes in a frontal surface or a side edge thereof, and wherein said faceplate has threaded holes formed on a back side thereof for holding said faceplate engaged in the frontal opening of said rigid cover.

29. The module case of claim 28, further including elongate threaded screws engaged between said faceplate and said rear cover plate to compressively hold said faceplate and said rear cover plate in the respective frontal and rear openings of said rigid cover.

30. The module case of claim 29, wherein said elongate threaded screws engage only said faceplate and said rear cover plate.

31. A module case for housing electrical components, comprising:

a rigid cover having a protective top panel, bottom panel, left side panel and right side panel, said rigid cover having a frontal opening and a rear opening;

a faceplate separate from said rigid cover for providing a frontal protective cover;

a rear cover plate separate from said rigid cover for providing a rear protective cover;

a plurality of elongate screws engageable with said rear cover plate and said faceplate, without being threadably engaged with said rigid cover, for compressively holding said rigid cover therebetween when said elongate screws are secured; and

a plurality of electrical contacts supported by said rear cover plate, said electrical contacts for providing electrical connections to components housed within said module case.

32. A module case for housing electrical components, comprising:

a rigid cover having a protective top panel, bottom panel, left side panel and right side panel, said rigid cover having a frontal opening and a rear opening;

a faceplate separate from said rigid cover for providing a frontal protective cover;

a rear cover plate separate from said rigid cover for providing a rear protective cover;

said left and right side panels each include a stop protruding from an inner surface thereof, and said faceplate and said rear cover panel have corresponding engaging surfaces engaging the stops, thereby enhancing the rigidity of the faceplate and the rear cover when attached to said rigid cover; and

a plurality of electrical contacts supported by said rear cover plate, said electrical contacts or providing electrical connections to components housed within said module case.

33. A module case for housing electrical components, and adapted for insertion into a chassis, comprising:

a three-sided rigid cover providing a protective top panel, bottom panel and a first side panel;

a second side panel constructed so as to be snap fittable to said top and bottom panels;

said three-sided rigid cover having a top and bottom elongate beveled corner, and said second side panel having a top and bottom elongate bevel corner, said beveled corners being adapted for guiding said module case when inserted into the chassis;

a faceplate separate from said rigid cover for providing a frontal protective cover;

a rear cover plate constructed of an insulator, and being separate from said rigid cover for providing a rear protective cover;

a plurality of electrical contacts individually supported by said insulator rear cover plate, said electrical contacts for providing electrical connections; and

a plurality of screws engaging with said faceplate and said rear cover plate for holding said three-sided rigid cover therebetween.

34. The module case of claim 33, wherein said plurality of screws compressively hold said three-sided rigid cover between said faceplate and said rear cover plate without being threadably fastened into said three-sided cover plate.

35. The module case of claim 33, wherein said second side panel is constructed so as to be snap fittable to said three-sided rigid cover.

* * * * *

US006044540A

United States Patent [19]

Fontana

[11] Patent Number: 6,044,540

[45] Date of Patent: Apr. 4, 2000

[54] **ELECTRONICS CHASSIS AND METHODS OF MANUFACTURING AND OPERATING THEREOF**

[75] Inventor: **Edward C. Fontana**, Rockwall, Tex.

[73] Assignee: **Lucent Technologies, Inc.**, Murray Hill, N.J.

[21] Appl. No.: **09/160,220**

[22] Filed: **Sep. 24, 1998**

Related U.S. Application Data

[62] Division of application No. 08/847,209, May 1, 1997.

[51] **Int. Cl.**[7] **B21D 39/00**

[52] **U.S. Cl.** **29/505**; 29/11; 29/434; 361/818; 361/816

[58] **Field of Search** 361/818, 816, 361/800, 690, 683, 796, 801, 753, 754, 746, 679; 29/505, 11, 434; 16/268; 220/836, 841

[56] **References Cited**

U.S. PATENT DOCUMENTS

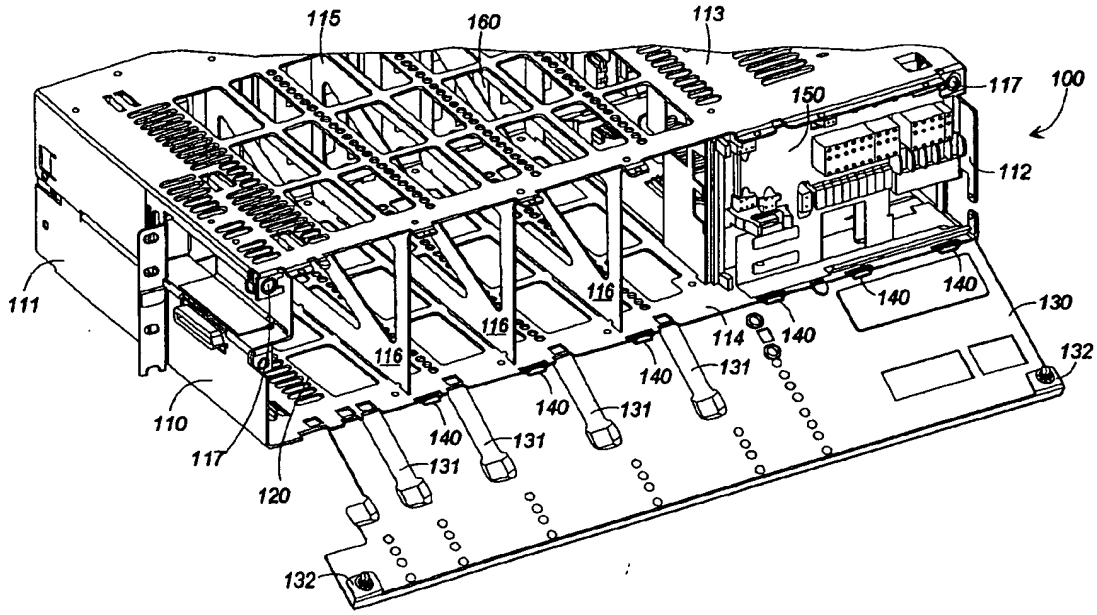
1,175,865	3/1916	Griswold et al.	220/326
1,396,876	11/1921	Platt	220/3.8
1,873,534	2/1932	Brethen	16/265
4,502,609	3/1985	Christatos	220/329
4,517,623	5/1985	Barner et al.	361/358
5,223,670	6/1993	Hogan et al.	174/35 MS
5,262,588	11/1993	Gallagher	174/35 R
5,561,893	10/1996	Lee	29/434
5,691,503	11/1997	Kato	174/35 R
5,691,504	11/1997	Sands et al.	174/35 R
5,701,231	12/1997	Do et al.	361/683
5,726,684	3/1998	Copeland et al.	361/800

Primary Examiner—David P. Bryant
Assistant Examiner—Jermie E. Cozart

[57] **ABSTRACT**

A chassis for containing electromagnetic interference ("EMI") generating equipment and methods of operation and manufacturing thereof. The chassis includes: (1) a cabinet having a base wall, the base wall having hinge race slots located along a forward edge thereof, lances between the hinge race slots and the forward edge forming hinge pins and (2) a door having arcuate hinge races extending from a hinge edge thereof and through corresponding ones of the hinge race slots to cooperate with the hinge pins to form hinges for the door. The hinge races have locking tabs extending laterally therefrom. The locking tabs have bent portions preventing the hinge races from being withdrawn from the hinge race slots.

7 Claims, 4 Drawing Sheets



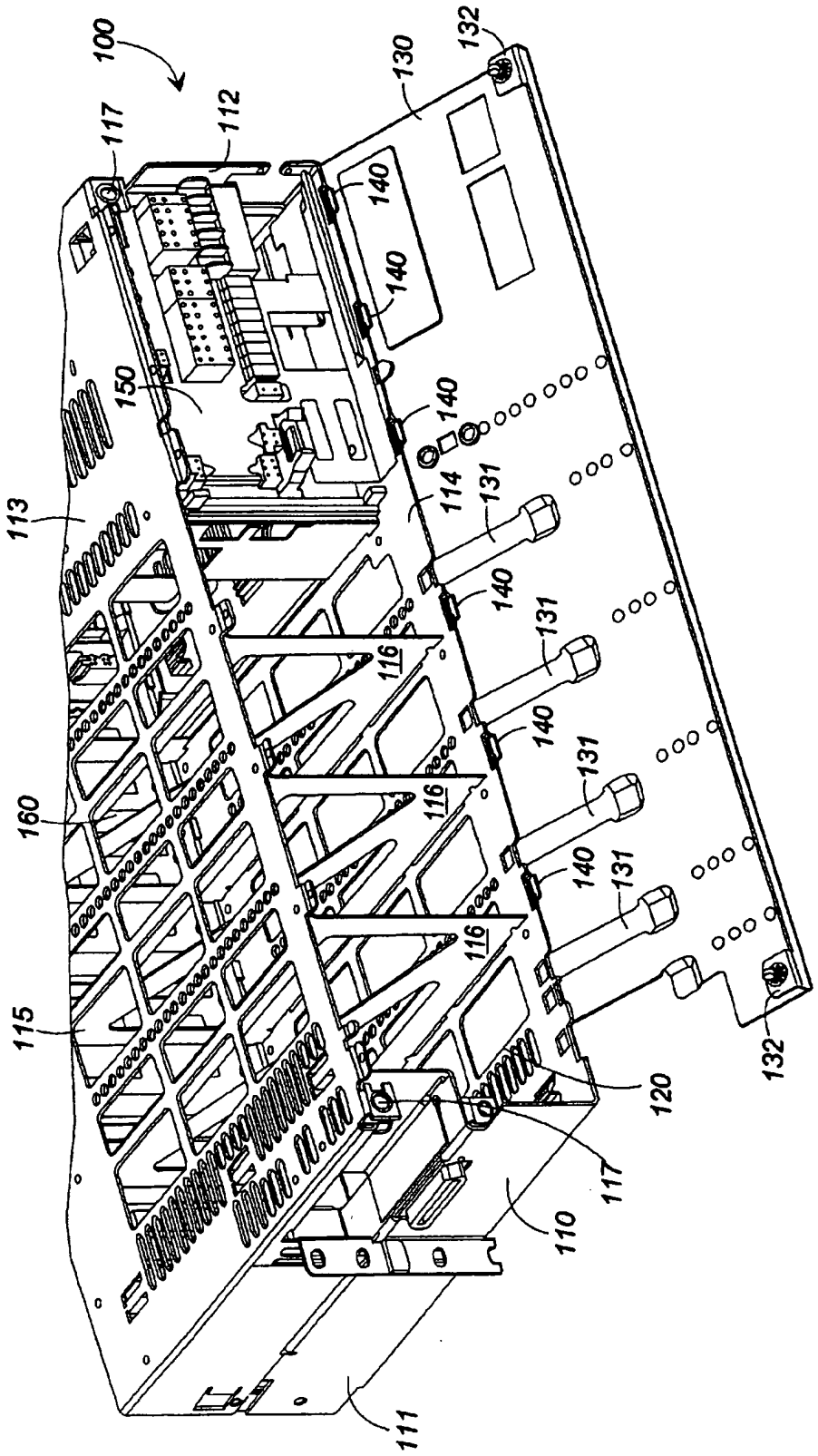


FIG. 1

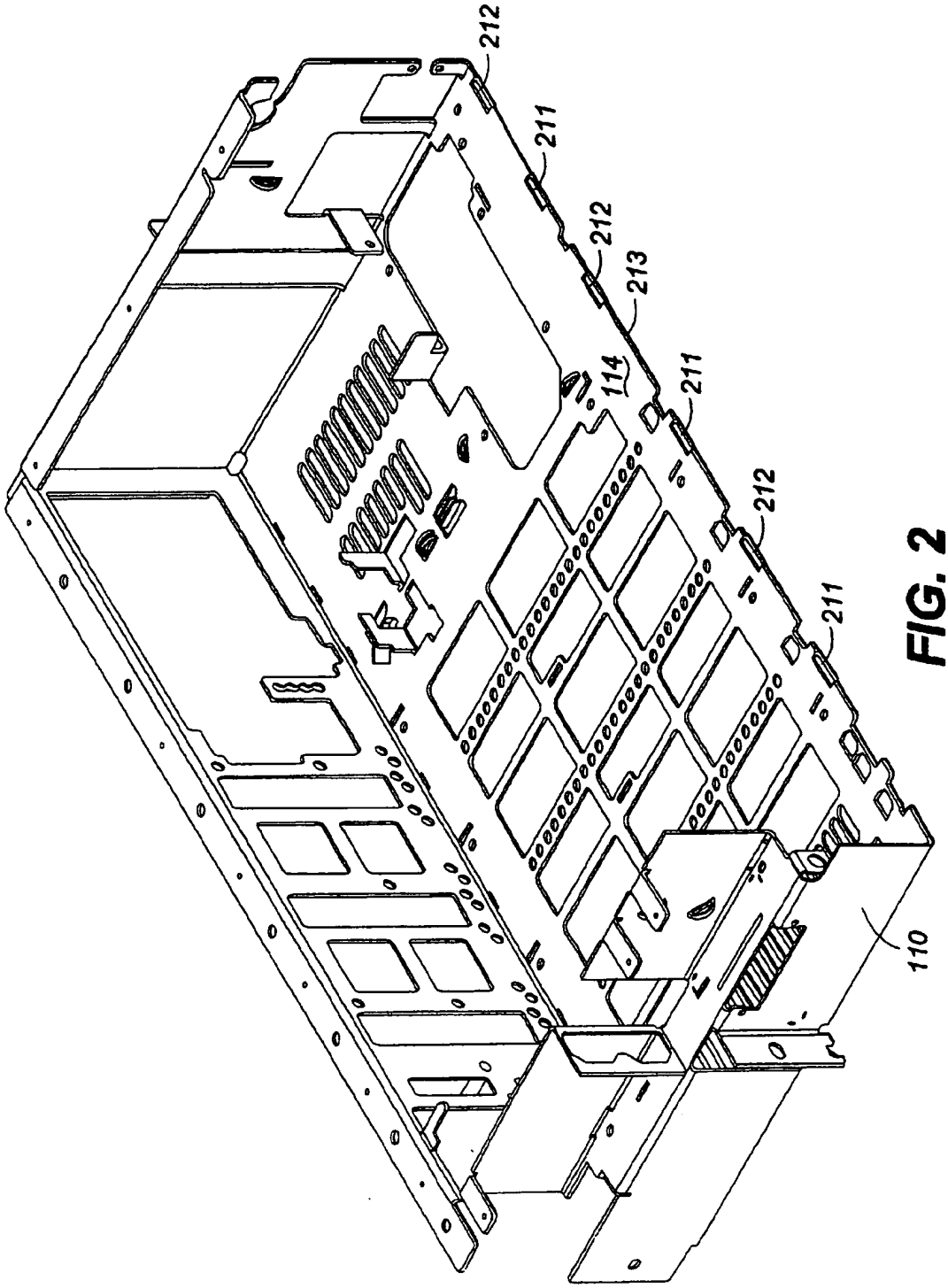


FIG. 2

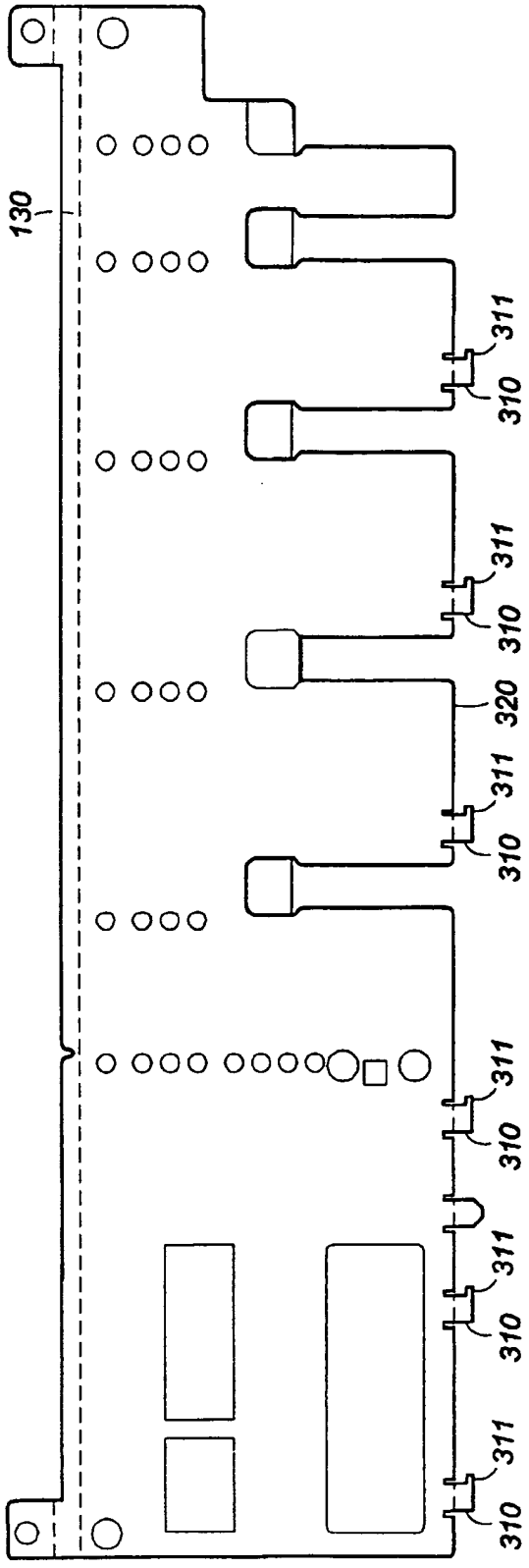


FIG. 3

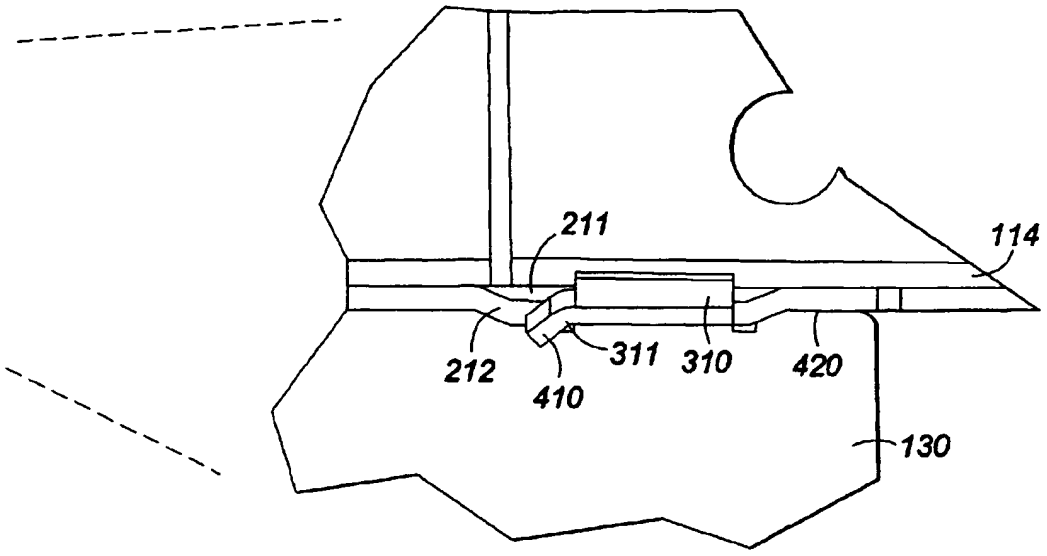


FIG. 4

ELECTRONICS CHASSIS AND METHODS OF MANUFACTURING AND OPERATING THEREOF

This application is a division of application Ser. No. 08/847,209, filed on May 1, 1997, currently pending. The above-listed Ser. No. 08/847,209 is commonly assigned with the present invention and is incorporated herein by reference.

TECHNICAL FIELD OF THE INVENTION

The present invention is directed, in general, to an electronics chassis, and more particularly to an electronics chassis for containing electronic equipment that generates electromagnetic interference ("EMI") and methods of manufacture and operation thereof.

BACKGROUND OF THE INVENTION

It has become customary to house electronic equipment, such as telecommunications equipment, in electronics chassis. Frequently, such chassis are designed to be rack-mountable to provide efficient storage for large quantities of equipment. In places where such large quantities of equipment are operated, space is typically at a premium. Accordingly, customers of chassis and racks are sensitive about devoting space to other than the equipment itself.

One type of chassis commonly encountered in rack-mountable form provides a means by which electrically to interconnect and cool equipment divided into modules and located in bays within the chassis. Such chassis are characterized by a rear cabinet and a hinged door on a front side thereof that can be opened to gain access to the modular equipment housed therein and closed to protect the modular equipment or to improve the cooling or appearance thereof.

It is necessary to provide a hinge for such doors that meets several, sometimes conflicting, requirements. First, the hinge should not add to the overall height of the chassis so as not to increase the overall height of the rack. Second, the hinge should not compromise the safety or structural integrity of the chassis as a whole; it should be able to withstand years of use. Third, the hinge structure should not impede the use of conventional equipment modules. In other words, the hinge should not protrude into the bays so as to interfere with the insertion or removal of equipment modules. Fourth, the hinge must not allow substantial EMI to escape from the chassis. Given the higher operating frequencies of today's telecommunications equipment, it is necessary to insure that long gaps that would allow radiation to escape from the chassis are not allowed to exist therein. Fifth, the hinge should not unduly add to the cost (material or labor) of manufacturing the chassis. Sixth, the hinge structure should not interfere with the serviceability of the chassis itself, apart from the equipment modules that may be located therein. Seventh, the hinge structure should not detract from the appearance of the front of the chassis. Eighth, the hinge structure should discourage significant amounts of air from passing into or out of the chassis around the door. As stated above, such chassis are frequently provided with a central cooling, requiring a defined flow for cooling air to be established through the chassis. Were the hinge structure to interfere with this flow by introducing an undesired inlet or outlet, the overall cooling capacity of the chassis could be compromised.

Finally, it is most desirable that the door be joined to the cabinet as a last step during manufacture thereof. The door usually is the most visible portion of the chassis and accordingly frequently contains graphics and other attractive designs that, were the door subjected to a larger part of the manufacturing process, could be damaged.

The obvious solution, and commensurate with that found in the prior art, is to provide a piano hinge that runs the length of the door. However, some chassis designs provide slots in the door to allow the equipment modules within the chassis to be viewed or contacted from without the chassis when the door is closed. The presence of the slots requires a piano hinge to be separated into many short lengths.

Some equipment modules require latches to engage and extract the modules from the backplane. To conserve space efficiencies, the latches are located low on the modules. Discontinuities must be introduced into a piano hinge to allow the latches to pass the hinge when the equipment modules are inserted into or removed from the chassis. Whether viewability or latch clearance is the issue in a given application, fabricating a discontinuous hinge to accommodate either can be quite difficult and expensive.

A less expensive solution is to eliminate the short lengths of piano hinge except for those at the extreme ends of the door. While this reduces somewhat the cost of manufacturing the chassis, the short lengths of piano hinge necessarily have long gaps therebetween that can admit or release EMI, degrading the electromagnetic performance of the chassis as a whole.

Therefore, what is needed in the art is a lower cost, more effective way of hinging a door to a cabinet to form an electronic chassis.

SUMMARY OF THE INVENTION

Accordingly, to address the above-described deficiencies of the prior art, the present invention provides a chassis for containing EMI-generating equipment, including: (1) a cabinet having a base wall, the base wall having hinge race slots located along a forward edge thereof, lances between the hinge race slots and the forward edge forming hinge pins and (2) a door having arcuate hinge races extending from a hinge edge thereof and through corresponding ones of the hinge race slots to cooperate with the hinge pins to form hinges for the door. The hinge races have locking tabs extending laterally therefrom. The locking tabs have a bent portion preventing the hinge races from being withdrawn from the hinge race slots.

The present invention therefore introduces a novel hinge mechanism employing locking tabs on the hinge races. When the locking tabs are bent, the hinge races are unable to pass through the hinge race slots and therefore cooperate to form a hinge for the door. The locking tabs may subsequently be unbent to allow the hinge races to be withdrawn from the hinge race slots, allowing the door to be removed from the cabinet.

In one embodiment of the present invention, the cabinet and the door are composed of metal, the hinges interrupting gaps between the forward edge and the hinge edge to attenuate the EMI. As described above, long gaps (on the order of several inches) between the door and the cabinet can act as a radiator, allow EMI to be admitted into or escape the chassis. The hinge structure described above can be employed to interrupt these gaps and prevent EMI from escaping.

In one embodiment of the present invention, the hinge edge of the door interferes with the base wall when the door achieves the desired maximum angle of rotation with respect to the base wall to prevent overrotation of the door.

In one embodiment of the present invention, the hinge pins are located without a plane of the base wall. In the

embodiment to be illustrated and described, the lances are urged outward (downward, as viewed upright) with respect to the cabinet. This allows the hinge to be clear of any modules (or latches thereof) that are placed within the chassis. Of course, this need not be the case.

In one embodiment of the present invention, the bent portions are displaceable to allow the hinge races to be withdrawn from the hinge race slots.

In one embodiment of the present invention, the door cooperates with the equipment to form a barrier as against air flow through the door when the door is in a closed position with respect to the cabinet. In an embodiment to be illustrated and described, the door has slots in it that allow visual inspection of, or contact with, modules within the chassis without having to open the door. When modules occupy the chassis, the slots are substantially blocked. The hinge of the present invention further prevents an obstacle to air flow from under the door, thereby help to maintain the desired air flow path within the chassis.

In one embodiment of the present invention, the chassis further comprises a latch that secures the door in a closed position with respect to the cabinet. The latch may be released to allow the door to open, perhaps to its desired maximum angle of rotation with respect to the base wall.

The foregoing has outlined, rather broadly, preferred and alternative features of the present invention so that those skilled in the art may better understand the detailed description of the invention that follows. Additional features of the invention will be described hereinafter that form the subject of the claims of the invention. Those skilled in the art should appreciate that they can readily use the disclosed conception and specific embodiment as a basis for designing or modifying other structures for carrying out-the same purposes of the present invention. Those skilled in the art should also realize that such equivalent constructions do not depart from the spirit and scope of the invention in its broadest form.

BRIEF DESCRIPTION OF THE DRAWINGS

For a more complete understanding of the present invention, reference is now made to the following descriptions taken in conjunction with the accompanying drawings, in which:

FIG. **1** illustrates a partial front side isometric view of one embodiment of the electronics chassis of the present invention;

FIG. **2** illustrates a front side isometric view of the cabinet of FIG. **1**;

FIG. **3** illustrates a reverse-angle elevational view of the door of FIG. **1** in a flat form prior to bending; and

FIG. **4** illustrates a detailed cutaway elevational view of a single hinge portion constructed according to the present invention.

DETAILED DESCRIPTION

Referring initially to FIG. **1**, illustrated is a partial front side isometric view of one embodiment of the electronics chassis of the present invention. The electronics chassis, generally designated **100**, comprises a cabinet **110** having a plurality of separate equipment module bays (one of which is referenced as **120**) therein for receiving one or more equipment modules (not shown), such as telecommunications equipment. The cabinet **110** comprises sidewalls **111**, **112**, a top wall **113** and a base wall **114**. Each of the top wall **113** and the bottom wall **114** is illustrated as having cooling ports, one of which is referenced as **115**, formed therein. The cooling ports **115** allow a cooling fluid, commonly air, to pass through the cooling ports **115** of the bottom wall **114** and the top wall **113** (vertically, if the chassis is oriented as shown in FIG. **1**). A plurality of dividers **116** define the equipment bays **120**.

The chassis **100** further includes control circuitry **150** that may be employed, for example, to provide common control or power for any equipment modules that may be inserted into the chassis **100**. The control circuitry is coupled to the equipment modules by a bus **160**, which may take the physical form of a "backplanes" on a rear wall of the cabinet **110**.

A door **130** is also shown. The door **130** is hingedly coupled to the cabinet **110** via a plurality of hinge portions, generally designated **140**, that cooperate to form a hinge for the door **130**. As described above, the hinge portions **140** offer several advantageous features. First, the hinge portions **140** allow the door **130** to rotate only up to a desired maximum angle of rotation with respect to the base wall **114**. Second, the hinge portions **140** are preferably flush with respect to the base wall **114**, allowing the equipment modules (not shown) to be inserted into or removed from the base **120** without interfering with the hinge portions **140**. This specific way in which this is accomplished will be described most particularly with reference to FIG. **4**, below. Third, the hinge portions **140** provide a plurality of grounding points between the door **130** and the cabinet **110**, interrupting gaps on the order of several inches that would, if present, radiate EMI from, or admit EMI into, the chassis **100**. Further, the hinge portions **140** are preferably hidden by the door **130** when viewed from the front of the chassis **100** with the door **130** closed. This enhances the overall appearance of the chassis **100**. Finally, it should be noted that the door **130** contains a plurality of vertical slots **131**. Each of the plurality of slots **131** is adapted to allow the front bezels or modular equipment (not shown) located in the chassis **100** to be viewed or contacted from the front of the chassis **100** when the door **130** is in a closed position. The bezels on the front of the modular equipment cooperate where the remainder of the door **130** to restrict airflow through the vertical slots **131**, ensuring that most airflow is realized by way of the cooling ports **115**.

Finally, FIG. **1** shows a pair of latches **132** on left and right ends (as illustrated) of the door **130**. The latches **132** mate with corresponding receptacles **117** in the cabinet **110** to allow the door **130** to be fixed in a closed position relative to the cabinet **110**. It should be noted at this point that FIG. **1** is shown mainly for the purpose of illustrating an environment in which the present invention can operate. Because the present invention is directed to a hinge, the shape, composition and contents of the cabinet **110** or other features of the door **130** are completely unnecessary to the present invention.

Turning now to FIG. **2**, illustrated is a front side isometric view of the cabinet **110** of FIG. **1**, minus many other structural elements of the chassis **100**, such as the dividers **116**, that were illustrated in FIG. **1**. FIG. **2** is included primarily for the purpose of illustrating the presence and relative relationship of a plurality of hinge race slots **211** and lances **212** located along a forward edge **213** of the cabinet **110**. Conventionally, the cabinet **110** is manufactured by a stamping process, wherein ports, slots and breaks are formed in a flat sheet of metal to fabricate the cabinet **110**. During this stamping process, the hinge race slots **211** and lances **212** may be formed without incurring additional manufacturing steps. Preferably, the lances **212** are formed outside of (offset from) the plane of the base wall **114** of the cabinet

110. The reason for this offset will be set forth in greatest detail in it conjunction with a description of FIG. 4, below.

Turning now to FIG. 3, illustrated is a reverse-angle elevational view of the door 130 of FIG. 1 in a flat form prior to bending. In other words, FIG. 3 illustrates an inner surface of the door 130. FIG. 3 is presented primarily for the purpose of showing details of the hinge races 310. The door 130 is illustrated as being initially stamped from a flat metal sheet. Following stamping, the hinge races 310 are bent into an arcuate shape. However, FIG. 3 shows the hinge races 310 before they have been so bent better to illustrate their shape. The hinge races 310 extend from a hinge edge 320 of the door 130 and are adapted to pass through corresponding ones of the hinge race slots 211 of FIG. 2 and thereafter to cooperate with the lances 212 (now acting as hinge pins) to form a hinge for the door 130. The hinge races 310 of FIG. 3 have locking tabs 311 extending laterally therefrom. The locking tabs 311 have bent portions (illustrated particularly in FIG. 4) that, when bent, prevent the hinge races 310 from being withdrawn from the hinge race slots 211 of FIG. 2.

Turning now to FIG. 4, illustrated is a detailed cutaway elevational view of a single hinge portion constructed according to the present invention. Shown are the base wall 114 and door 130 of FIG. 1. Also shown are one each of the hinge race slots 211 and lances 212 (now acting as a hinge pin) of FIG. 2. Further shown are one each of the hinge races 310 and locking tabs 311 of FIG. 3. It can now be seen that the hinge race 310 is bent into an arcuate shape and extends through the hinge race slot 211. It can also be seen now that the locking tab 311 contains a bent portion 410. As the door 130 is rotated toward a fully open position, a hinge edge 420 of the door 130 rotates about and eventually comes into interference with the base wall 114 when the door 130 reaches a desired maximum angle of rotation with respect to the base wall 114. This prevents overrotation of the door 130 with respect to the base wall 114. The hinge edge 420 may be extended downward (as the door 130 is shown in FIG. 4) to decrease the desired maximum angle of rotation or may be reduced in length to increase the desired maximum angle of rotation.

It is further illustrated in FIG. 4 that the hinge race 310 does not extend above the plane of the base wall 114. This is because the lance 212 was formed below the plane of the base wall 114 by a distance at least equaling a thickness of the metal constituting the door 130. This ensures that the hinge portion does not interfere with the insertion or removal of equipment modules.

A method of manufacturing the chassis of the present invention may be as follows. First, the cabinet 110 is formed by means of a stamping process. Second, structures within the cabinet 110, such as dividers and an electrical backplane, may be added. Third, the door 130 is formed, preferably also by a stamping process. Fourth, the hinge races 310 are bent into an arcuate shape. (However, it is noted that the locking tabs 311 should remain unbent, allowing the hinge races 310 to be inserted through the hinge race slots 211.) Next, the hinge races 310 are inserted through the hinge race slots 211. The locking tabs 311 are then bent with respect to the remainder of the hinge races 310. This may be done by means of twisting by, for instance, conventional needlenose pliers. This forms the bent portion 410 illustrated most clearly in FIG. 4.

Creating a bent portion 410 in each hinge race 310 causes the hinge races 310 to resist being withdrawn from the hinge race slots 211, thereby preventing the door 130 from being separated from the base wall 114. Further, the hinge edge 420 of the door 130 is brought into alignment with the base wall 114, causing them to act as overrotation limits to prevent the door 130 from exceeding a desired maximum angle of rotation with respect to the base wall 114;

From the above, it is apparent that the present invention provides a chassis for containing EMI-generating equipment. The chassis comprises: (1) a cabinet having a base wall, the base wall having hinge race slots located along a forward edge thereof, lances between the hinge race slots and the forward edge forming hinge bends and (2) a door having arcuate hinge races extending from a hinge edge thereof and through corresponding ones of the hinge race slots to cooperate with the hinge pins to form hinges for the door. The hinge races have locking tabs extending laterally therefrom. The locking tabs have bent portions preventing the hinge races from being withdrawn from the hinge race slots.

Although the present invention has been described in detail, those skilled in the art should understand that they can make various changes, substitutions and alterations herein without departing from the spirit and scope of the invention in its broadest form.

What is claimed is:

1. A method of manufacturing a chassis for containing electromagnetic interference (EMI)-generating equipment, comprising the steps of:

forming a cabinet having a base wall, said base wall having hinge race slots located along a forward edge thereof, lances located between said hinge race slots and said forward edge forming hinge bends;

forming a door having arcuate hinge races extending from a hinge edge thereof, said hinge races having locking tabs extending laterally therefrom;

inserting said hinge races through corresponding ones of said hinge race slots, said hinge races and said hinge race slots cooperating to form hinges for said door; and

bending said locking tabs to form bent portions thereon, said bent portions preventing said hinge races from being withdrawn from said hinge race slots.

2. The method as recited in claim 1 wherein said cabinet and said door are composed of metal, said hinges interrupting gaps between said forward edge and said hinge edge to attenuate electromagnetic interference.

3. The method as recited in claim 1 further comprising the step of locating said hinge edge of said door to interfere with said base wall when said door achieves a desired maximum angle of rotation with respect to said base wall to prevent overrotation of said door.

4. The method as recited in claim 1 wherein said step of forming said cabinet comprises the step of forming said lances offset from a plane of said base wall.

5. The method as recited in claim 1 further comprising the step of displacing said bent portions to allow said hinge races to be withdrawn from said hinge race slots.

6. The method as recited in claim 1 wherein said door cooperates with said equipment to form a barrier against air flow through said door when said door is in a closed position with respect to said cabinet.

7. The method a s recited in claim 1 further comprising the step of securing said door in a closed position with respect to said cabinet with a latch coupled to said door and said cabinet.

* * * * *

US006456495B1

(12) **United States Patent**
Wieloch et al.

(10) **Patent No.: US 6,456,495 B1**
(45) **Date of Patent: Sep. 24, 2002**

(54) **LOGIC CONTROLLER HAVING DIN RAIL BACKPLANE AND LOCKING MEANS FOR INTERCONNECTED DEVICE MODULE**

(75) Inventors: **Christopher John Wieloch**; **Anthony Edward Develice**, both of Brookfield; **Michael Thomas Little**, Milwaukee, all of WI (US)

(73) Assignee: **Eaton Corporation**, Cleveland, OH (US)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

(21) Appl. No.: **09/523,607**

(22) Filed: **Mar. 13, 2000**

(51) **Int. Cl.**[7] **H05K 7/14**

(52) **U.S. Cl.** **361/729**; 361/683; 361/732; 361/801; 361/802; 361/788; 312/215; 312/222; 312/228.1; 312/223.2

(58) **Field of Search** 361/729, 686, 361/732, 728, 724, 725, 801, 802, 759, 788; 312/215, 216, 222, 228.1, 223.2

(56) **References Cited**

U.S. PATENT DOCUMENTS

4,738,632 A	*	4/1988	Schmidt et al.	439/341
5,031,075 A	*	7/1991	Casanova et al.	361/802
5,043,847 A	*	8/1991	Deinhardt et al.	361/736
5,222,897 A	*	6/1993	Collins et al.	439/157
5,227,957 A	*	7/1993	Deters	361/686
5,432,682 A	*	7/1995	Giehl et al.	361/796
5,455,744 A		10/1995	Watanabe	361/801
5,822,184 A	*	10/1998	Rabinovitz	361/685
6,052,278 A	*	4/2000	Tanzer et al.	361/685
6,252,765 B1	*	6/2001	Balzaretti et al.	361/683

FOREIGN PATENT DOCUMENTS

DE	3331035 A1	4/1984	G05B/11/01

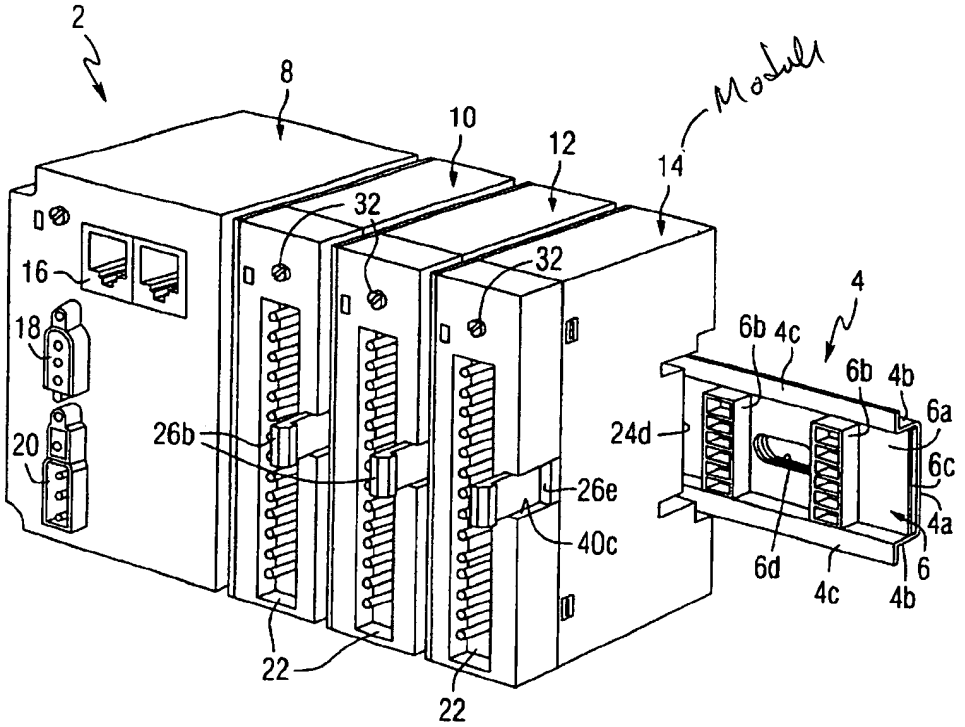
* cited by examiner

Primary Examiner—Leo P. Picard
Assistant Examiner—David Foster
(74) *Attorney, Agent, or Firm*—Martin J. Moran

(57) **ABSTRACT**

A logic controller formed by self-contained device modules plugged onto a DIN rail and onto a backplane contained in the DIN rail, the modules variously comprising a power supply, a logic control, I/O devices and gateways, each I/O device having microprocessor power, and the modules having a sliding lock movable into position adjacent DIN-rail-engaging flexible tabs to block deflection of the tabs and removal of the module from the DIN rail.

11 Claims, 5 Drawing Sheets



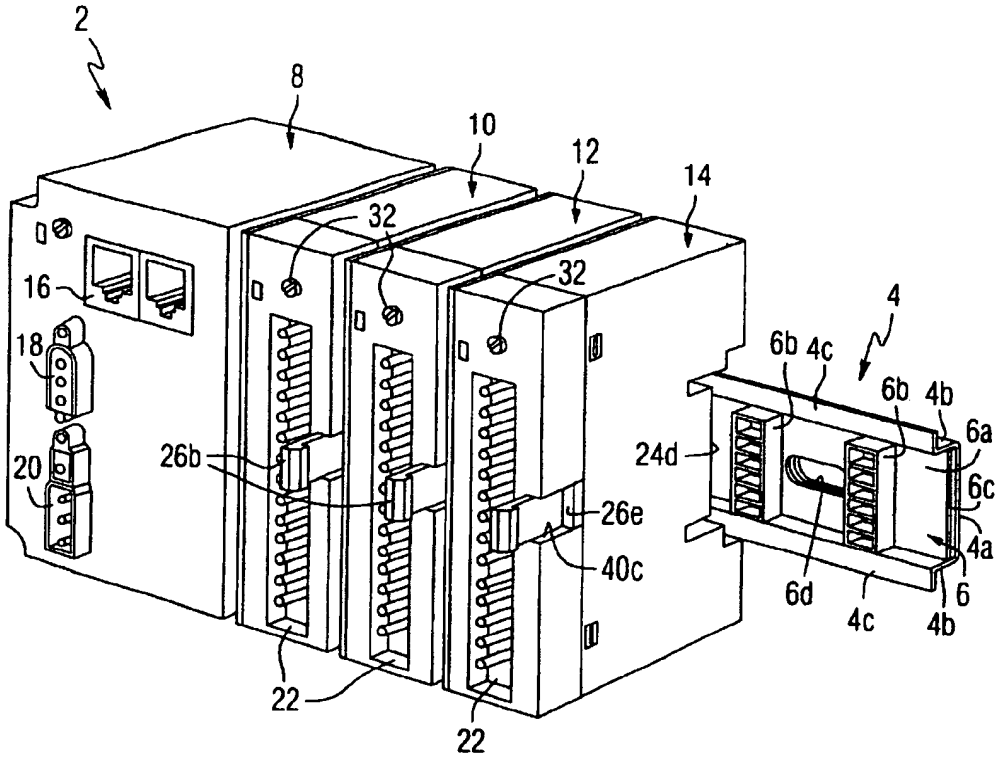

2
8
10
12
14
32
32
32
16
18
20
26b
26e
40c
22
22
4
6b
4c
6b
4b
6a
24d
6c
4a
6
6d
4c
4b

FIG. 1

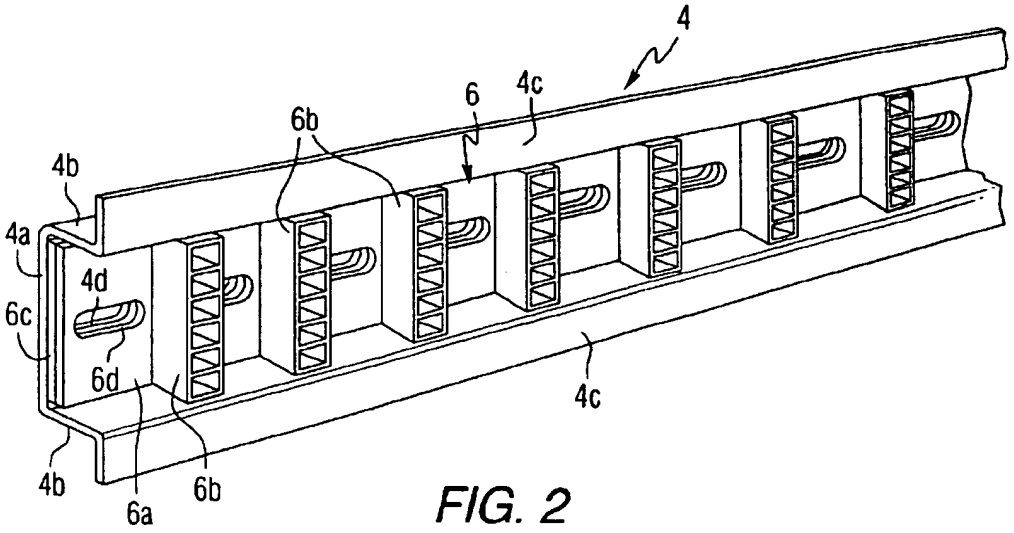

4
6
4c
6b
4b
4a
4d
6c
6d
4c
4b
6a
6b

FIG. 2

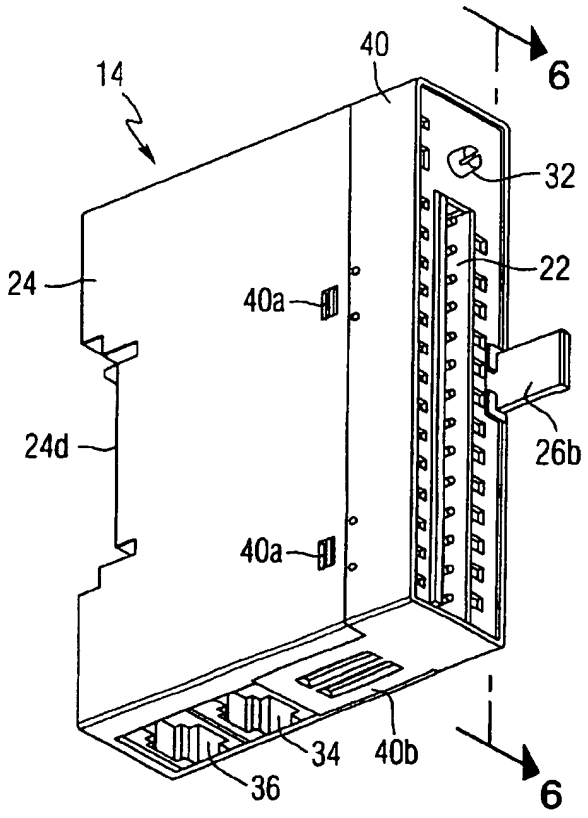

14
40
6
32
22
24
40a
26b
24d
40a
34
40b
36
6

FIG. 3

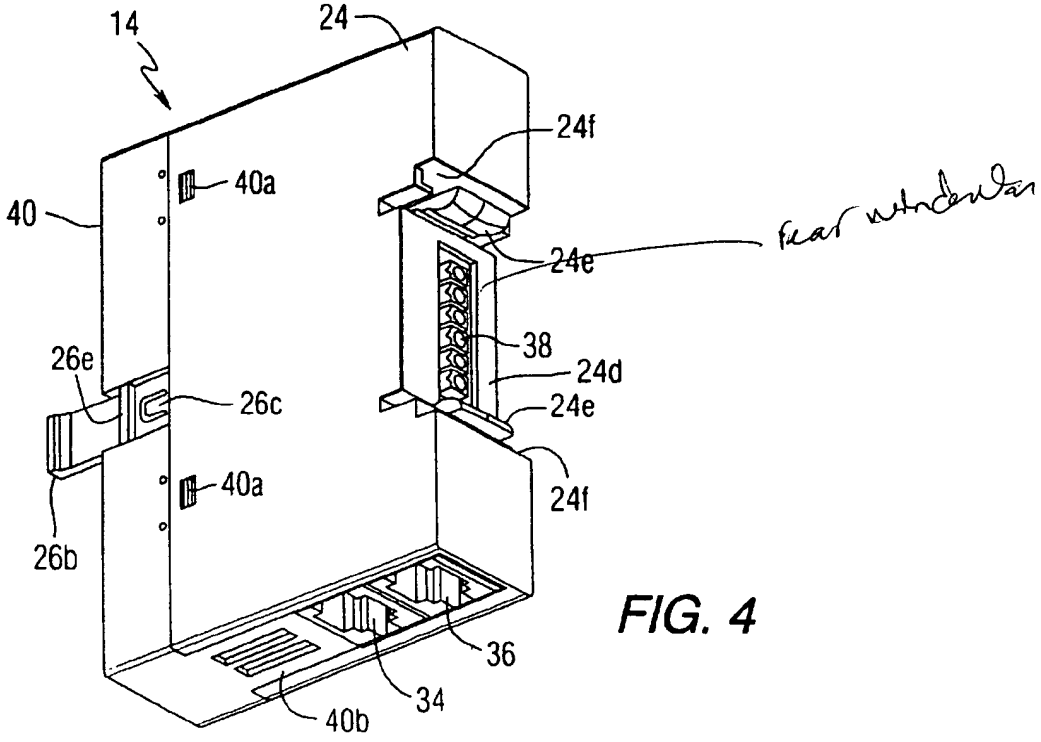

14
24
24f
40a
40
rear window
24e
38
26e
24d
26c
24e
40a
24f
26b
36
34
40b

FIG. 4

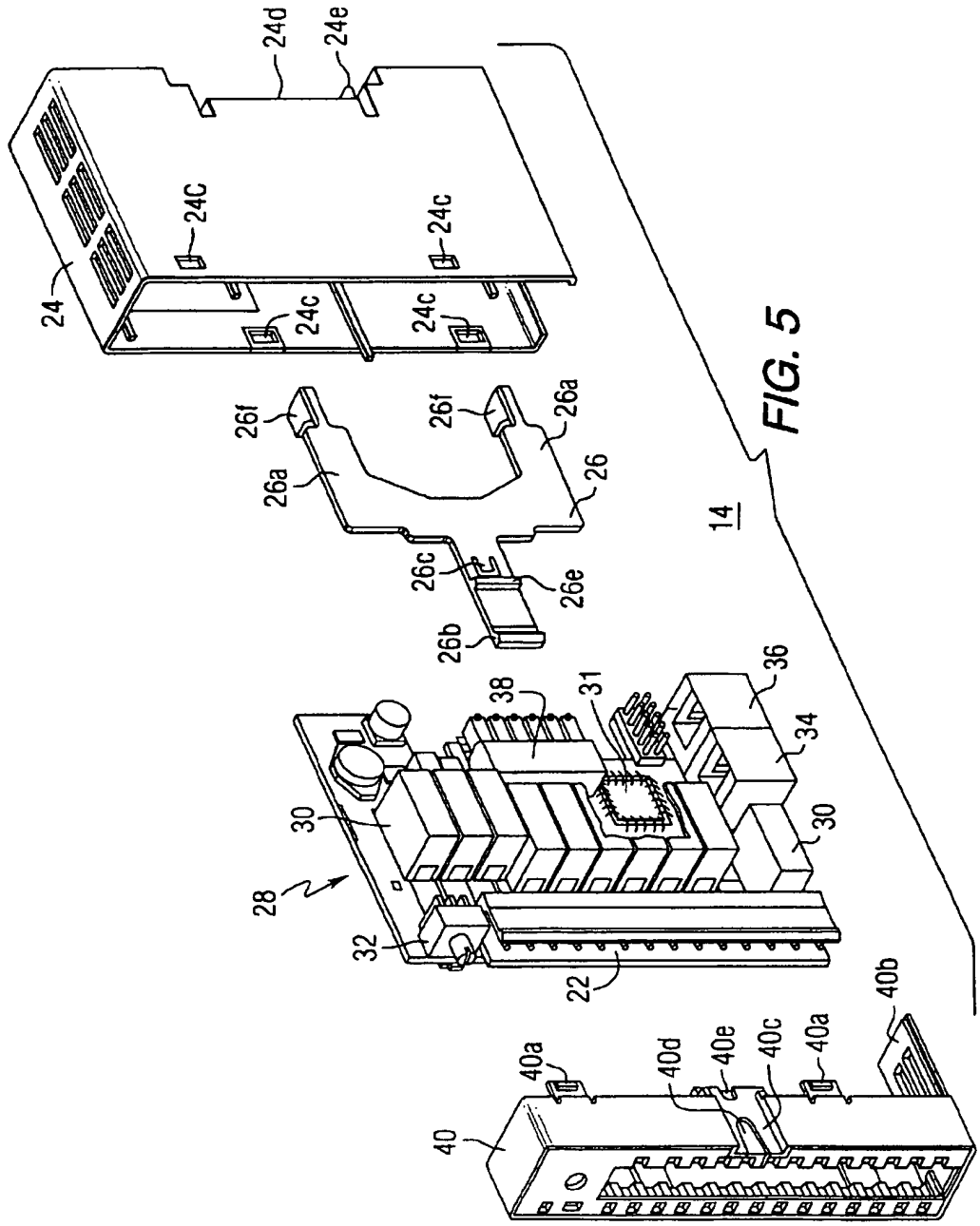

24d
24e
24C
24c
24
24c
24c
24c
26f
26f
26a
26a
26
26c
26e
26b
14
36
38
31
34
30
30
28
32
22
40b
40a
40d
40e
40c
40a
40

FIG. 5

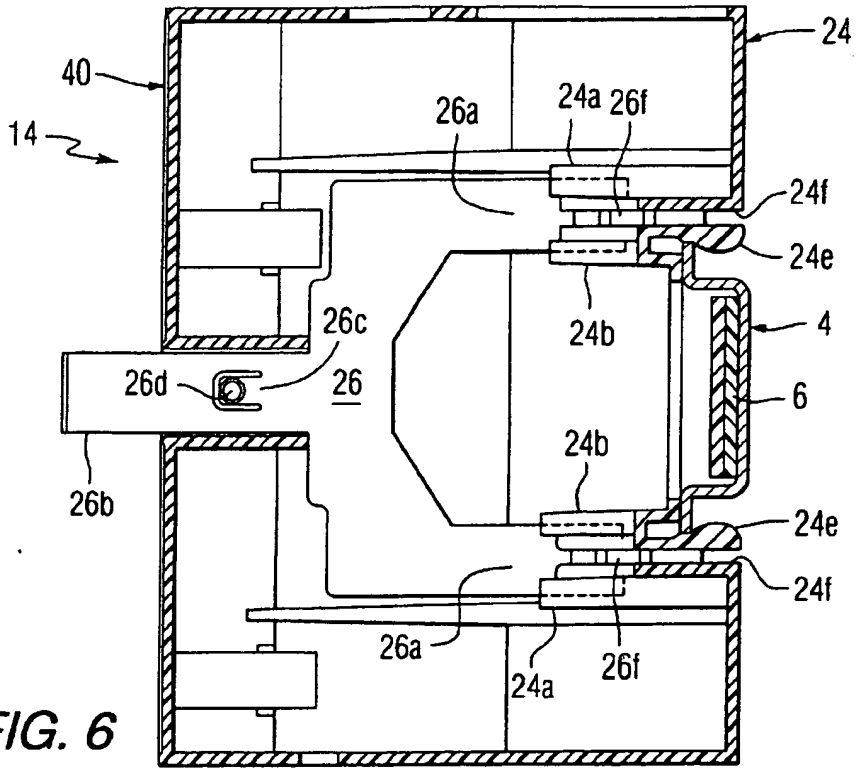


FIG. 6

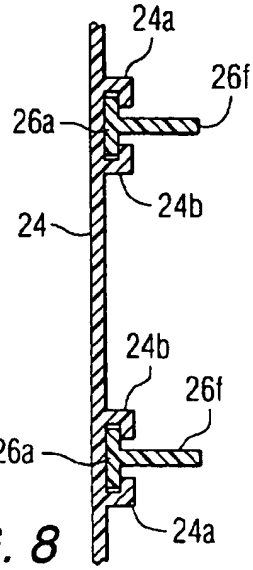


FIG. 8

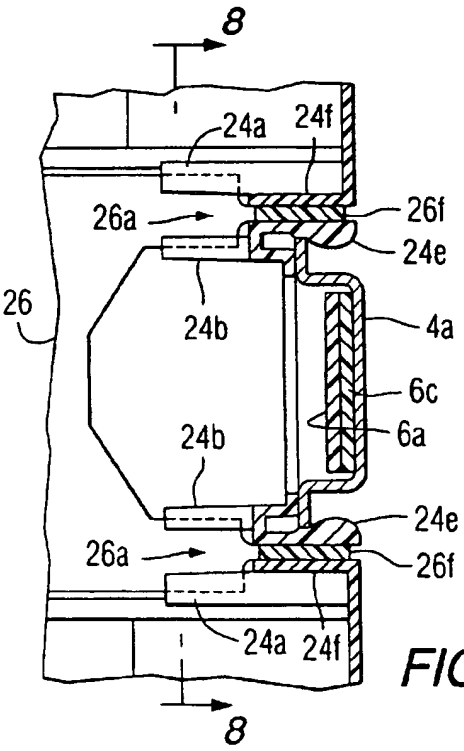


FIG. 7

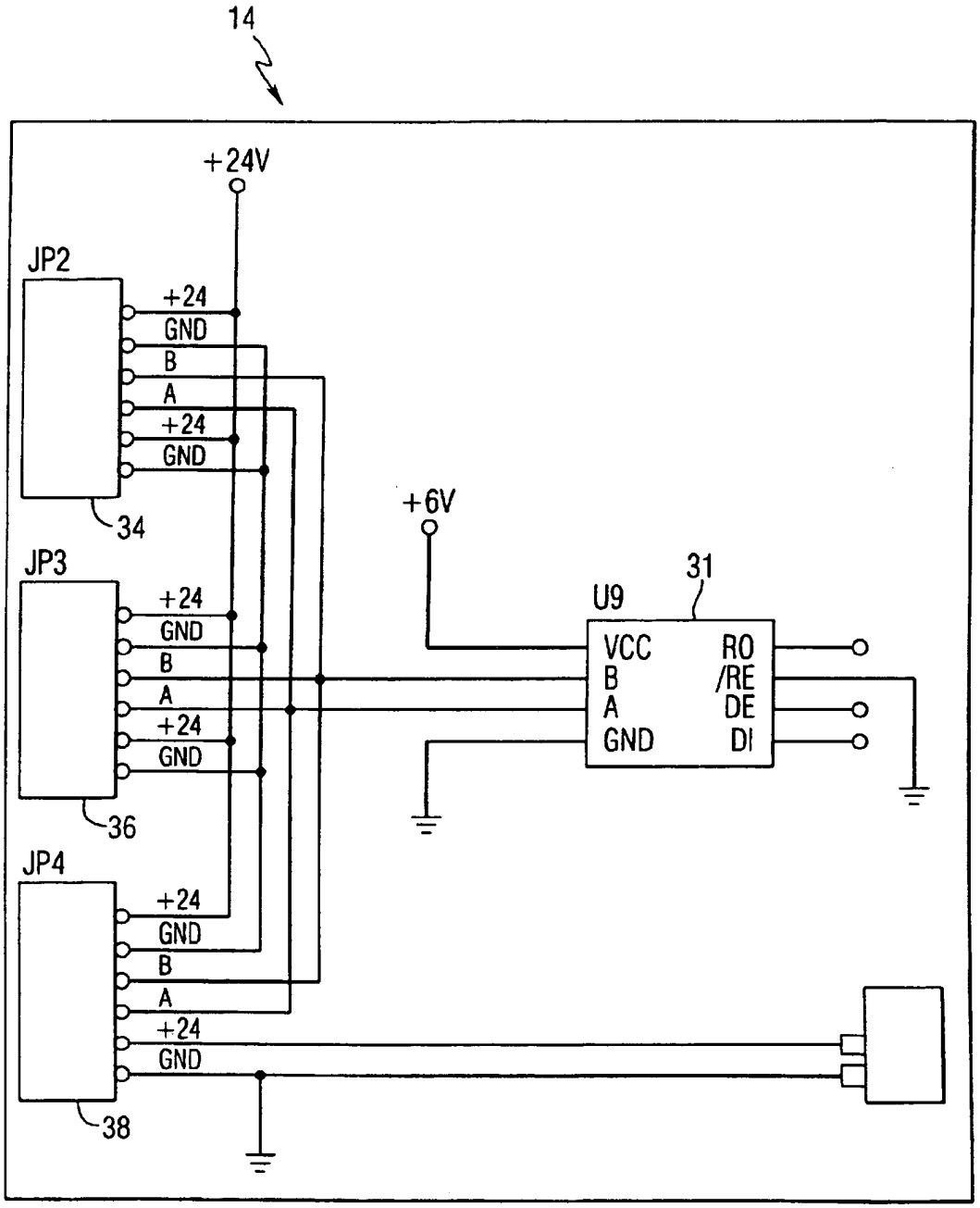

14
+24V
JP2
+24
GND
B
A
+24
GND
34
+6V
31
U9
VCC
B
A
GND
RO
/RE
DE
DI
JP3
+24
GND
B
A
+24
GND
36
JP4
+24
GND
B
A
+24
GND
38

FIG. 9

LOGIC CONTROLLER HAVING DIN RAIL BACKPLANE AND LOCKING MEANS FOR INTERCONNECTED DEVICE MODULE

CROSS-REFERENCE TO RELATED APPLICATIONS

Not Applicable

STATEMENT REGARDING FEDERALLY SPONSORED RESEARCH OR DEVELOPMENT

Not Applicable

MICROFICHE APPENDIX

Not Applicable

BACKGROUND OF THE INVENTION

The present invention relates to logic controllers. Particularly this invention relates to plug-in device modules such as I/O modules which attach to a logic controller backplane. Such controllers commonly have the backplane mounted within an open molded housing to which the plug-in modules are attached at predetermined locations to complete the housing and plug in to the backplane. In such apparatus, neither the housing containing the backplane nor the plug-in device module represent complete stand-alone enclosed assemblies. Known controllers are restricted in an ability to expand or be connected to remote modules or controllers.

BRIEF SUMMARY OF THE INVENTION

This invention provides a logic controller wherein device modules for the logic controller are individual, self-contained device modules which may be mounted directly to a DIN rail. Moreover, this invention provides a logic controller having device modules of the aforementioned type and wherein the backplane for the logic controller is mounted directly to the DIN rail. The device modules are attached to the DIN rail in a straight-on motion which facilitates a plug-in connection with a connector of the backplane and are secured to the DIN rail and to the backplane by a single lock lever accessible from the front of the device module. Still further this invention provides a device module which is capable of active attachment to a backplane and which may be connected in parallel with the backplane to a remote module by means of a jumper to the remote device. This device module is further capable of daisy chain connection from one module to another if a backplane connection is not available or desired. The invention, its features and advantages, will become more readily apparent in the following description when read in conjunction with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a three-dimensional showing of a logic controller comprising a DIN rail having a backplane assembly and a plurality of device modules attached to the DIN rail and backplane;

FIG. **2** is a three-dimensional view of the DIN rail and backplane assembly of this invention;

FIG. **3** is an isometric view of an individual device module from FIG. **1**, viewed from the lower front of that device;

FIG. **4** is an isometric view of the device module of FIG. **3** viewed from the lower back of the device;

FIG. **5** is an exploded isometric view of the device module of FIGS. **3** and **4**;

FIG. **6** is a cross-sectional view of the device module of this invention taken along the line **6—6** in FIG. **3**;

FIG. **7** is a fragmentary cross-sectional view similar to FIG. **6**, but showing a lock lever in an operated position;

FIG. **8** is a fragmentary cross section view taken along the line **8—8** in FIG. **7**; and

FIG. **9** is a schematic view of the device module of this invention showing electrical interconnection of connectors for the module.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

A logic controller **2** constructed according to the invention is shown in FIG. **1**. A DIN rail **4**, shown separately in FIG. **2**, comprises an elongated channel having a flat base **4***a*, forwardly directed lateral side walls **4***b* and outwardly directed mounting flanges **4***c* along the forward edges of side walls **4***b*. A plurality of longitudinally spaced openings **4***d* are provided in the base **4***a* along the length thereof for mounting the DIN rail to a panel or the like.

A backplane assembly **6** is secured to the base **4***a* of DIN rail **4**. Backplane assembly **6** comprises an elongated multilayer laminated printed wire board (PWB) **6***a* having traces printed on several of the layers according to a well known process. The trace pattern of the several layers is not specifically shown, but it is such as to provide power and communication bus along the length of the assembly. The PWB **6***a* is provided with through hole patterns at spaced intervals along the length to which pin connectors **6***b* are attached. The pins extend through the holes in the PWB **6***a* and connect to the particular traces. The pins are held within the insulating housing of the connector **6***b* such that the housing is trapped against the front surface of PWB **6***a*. An insulator strip **6***c* is affixed to the back side of PWB **6***a* by an adhesive or the like. PWB **6***a* and strip **6***c* have longitudinally spaced openings **6***d* which generally correspond with the openings **4***d* in the DIN rail base. Backplane assembly **6** is preferably affixed to the base **4***a* of DIN rail **4** by an adhesive, although mechanical attachments such as by rivets is also contemplated.

A plurality of device modules **8**, **10**, **12** and **14** are attached to the DIN rail **4** and backplane assembly **6** as can be seen in FIG. **1**. Device module **8** is a power supply module and typically is a double width module. Power supply module **8** has a double element phone jack communication connector **16**, a three-pin communication connector **18** and a power connector **20**, all accessible at a front face thereof. Device modules **10**, **12** and **14** are I/O modules, each essentially identical externally. Each I/O module **10**, **12** and **14** has a multi-pin connector **22** in the front face for receiving a hard-wired connection plug (not shown). Other modules may be attached to the DIN rail and backplane assembly such as a logic controller, network gateways, or the like.

The I/O device module **14** is shown individually in FIGS. **3**, **4** and **5** as being typical of the modules **10**, **12** and **14**. It comprises a hollow insulating housing **24** which is open to the front. A Y-shaped lock lever **26** is disposed in housing **24** against a near side wall as oriented in FIG. **5**. The distal ends **26***a* of the upper legs of the Y-shaped lock lever are slidably received within slots formed by molded projections **24***a* and **24***b* on the side walls (FIGS. **6**, **7** and **8**). The base **26***b* of the Y-shaped lock lever forms the handle for the lock lever as will become apparent hereinafter. A logic board assembly **28** is also disposed within the insulating housing **24**. The particular module **14** illustrated is an output module and thus

the logic board **28** is a relay board containing ten relays **30** and other components of the output device such as a microprocessor controller chip **31**, and the like. The multiple pin connector **22** is affixed along the left-hand forward edge of the logic board as viewed in FIG. **5**. An address setting rotary dip switch **32** is mounted immediately above the connector **22**. A pair of phone jack plugs **34** and **36** are positioned along a lower edge of the board and a six-pin connector **38** is positioned at the back edge of the board.

Although not shown, the interior of housing **24** and of a cover member **40** are suitably configured to engage and hold the logic board assembly **28** securely in place when the enclosure assembly is completed. Cover member **40** has a plurality of snap tabs **40***a* which engage rectangular openings **24***c* in housing **24** to attach the cover **40** to the housing **24**. The lower wall of cover **40** as oriented in FIG. **5** has an extension **40***b* that fills a space in housing **24** adjacent phone jack connectors **34** and **36** to complete the lower wall of the module. One side wall of cover **40** has a central recess **40***c* into which handle **26***b* of lock lever **26** is disposed for sliding movement. The inner face of recess **40***c* has a pair of sub-recesses **40***d* and **40***e*. Lock lever **26** has a resilient tab **26***c* formed by a U-shaped slot in the base of that lever. A domed-shaped projection **26***d* is formed on one side of the tab **26***c* to engage in either sub-recess **40***d* or **40***e* as determined by the position of the lock lever **26**, i.e., whether the lock lever is extended in its inoperative position or depressed to its operative position as will be apparent hereinafter. Immediately forward of tab **26***c* is a transverse bar **26***e* integrally formed on the lock lever which abuts the forward edge of housing **24** in the depressed, operative position of the lock lever to positively locate the operating position of the lever. Cover number **40** further has appropriate openings in the front face thereof for indicator LED's (not specifically shown), the adjusting knob of rotary dip switch **32**, and the multiple pin connector **22**.

Referring particularly to FIGS. **4** and **6**, the back wall of housing **24** is centrally recessed at **24***d*. A pair of flexible tabs **24***e* are integrally molded on the housing, and extend rearward along opposite ends of the recessed area **24***d*. The facing surfaces of tabs **24***e* have curved convex bosses thereon which provide an interference with outer edges of flanges **4***c* of DIN rail **4** when the device module **14** is attached to the DIN rail. Straight-on pressure to the module **14** causes the tabs **24***e* to deflect outwardly away from each other and snap over the edges of the DIN rail flanges **4***c*. When the surface of recess **24***d* seats flush against the forward surface of DIN rail flanges **4***c*, the flexible tabs **4***e* spring back inwardly to grip the edges and hold the module tightly against the flanges.

The aforedescribed attachment of module **14** to DIN rail **4** also effects plug-in connection between connector **38** (accessible through an opening in recessed area **24***d* of housing **24**) and a connector **6***b* of the backplane assembly.

Housing **24** has wall portions **24***f* spaced from and parallel with tabs **24***e*. Openings are provided in housing **24** adjacent the roots of tabs **24***e*, through which openings offset ends **26***f* of the distal ends **26***a* of lock lever **26** project. Movement of lock lever **26** to its depressed position wherein bar **26***e* abuts the forward edge of housing **24**, moves offset ends **26***f* into the space between wall portions **24***f* and flexible tabs **24***e*, thereby blocking outward movement of the tabs away from each other and securely holding the module **14** to DIN rail **4** and backplane assembly **6**. Therefore, attachment of plugs to the pin connectors **22** at the front of the device modules can be made without concern that the module itself will come loose from its backplane connection.

Phone jack connectors **34** and **36** are connected in parallel with connector **38** as may be seen in FIG. **9**, thereby enabling parallel connection of the logic controller on DIN rail **4** to another remote module or controller by means of a jumper from the appropriate phone jack connectors **34** and **36** to the similar connectors on the remote device. Alternatively, the device modules may be attached to a customary DIN rail not having the backplane assembly **6** and be daisy chain connected by jumpers via the phone jacks **34** and **36** in a known manner.

The foregoing has described a particular improved logic controller which eliminates a need for a separate housing member for a backplane assembly. Although the logic controller, DIN rail and backplane assembly and the device modules have been shown in a single preferred embodiment representing the best mode contemplated of carrying out the invention, it is to be understood that the invention is susceptible to various modifications and changes without departing from the scope of the appended claims.

What is claimed is:

1. Logic control apparatus comprising:

a DIN rail mounting channel having an elongated base, fowardly directed walls along opposite longitudinal edges of said base, and co-planar flanges extending outwardly along respective distal edges of said walls;

an elongated backplane assembly carried by said DIN rail adjacent said base, said backplane assembly comprising a printed wire board having conductive traces thereon, and plug-in connectors attached thereto at longitudinally spaced intervals, said plug-in connectors being electrically connected to said conductive traces and projecting forwardly between said walls; and

device modules attached to said DIN rail flanges, said device modules each comprising means securing said device module to said flanges, and a logic board comprising a backplane connector coupled to a respective said plug-in connector, remote device connector means, logic control means for processing electrical signals between said remote device connector means and said backplane connector, and a switch selectively settable for assigning a network address for said module.

2. The logic control apparatus defined in claim **1** wherein each device module comprises a pair of phone jack connectors connected in parallel with said backplane connector for alternate daisy chain connection of said modules and for jumpered connection to a remote device module.

3. The logic control apparatus defined in claim **2** wherein said logic control means comprises a microprocessor.

4. The logic control apparatus defined in claim **1** wherein said device module comprises a housing and cover assembled to provide a unitary enclosure for said device module, said housing and cover having respective openings for access to said backplane connector, remote device connector means and said switch.

5. The logic control apparatus defined in claim **4** wherein said securing means comprises flexible tabs projecting from said housing, said tabs having inwardly convex bosses on respective facing surfaces engageable with outer edges of said DIN rail flanges, said tabs being deflected outwardly by said flanges when said module is pressed onto or pulled from said DIN rail.

6. The logic control apparatus defined in claim **5** wherein said securing means comprises a lock lever slidably mounted in said housing, said lock lever having a handle extending outside said housing at a forward portion of said housing, said lock lever further having portions aligned in

openings in said housing adjacent said tabs, depression of said lock lever handle portion into said housing effecting movement of said portions alongside said tabs, blocking outward deflection of said tabs.

7. The logic control apparatus defined in claim **6** wherein said housing comprises rigid wall segments parallel to respective said tabs to define spaces between said segments and said tabs, said lock lever portions moving into said spaces upon depression of said lock lever handle portion filling said spaces.

8. Logic control apparatus comprising:

a Din rail mounting channel;

a backplane assembly affixed to said DIN rail, said backplane assembly having a plurality of plug-in connectors;

a power supply module attached to said DIN rail and connected to at least one of said plug-in connectors;

device modules attached to said DIN rail, each device module connected to a

respective plug-in connector and having a selector switch manually operable for

setting a network address for a respective said device module.

9. The logic control apparatus defined in claim **8** wherein said device modules each comprise microprocessor logic controller means.

10. The logic control apparatus defined in claim **9** wherein said device modules each comprise connector jacks for daisy chain and remote device connection, said connector jacks being connected electrically in parallel with said device module connection to said respective plug-in connector of said backplane.

11. The logic control apparatus defined in claim **8** wherein each said device module comprises an enclosure having resilient tabs for gripping said DIN rail, said tabs being deflectable away from each other in attachment and detachment from said DIN rail, and said device module further comprises a slidable lock lever having blocking portions selectively movable into positions adjacent outer surfaces of said resilient tabs blocking deflection of said tabs.

* * * * *

US006202291B1

(12) **United States Patent**
Toedtman

(10) **Patent No.: US 6,202,291 B1**
(45) **Date of Patent: Mar. 20, 2001**

(54) **APPARATUS FOR ALIGNING DEVICE INTERCONNECTIONS**

(75) Inventor: **Thomas Toedtman**, Aptos, CA (US)

(73) Assignee: **Greystone Peripherals**, Los Gatos, CA (US)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

(21) Appl. No.: **09/439,773**

(22) Filed: **Nov. 12, 1999**

Related U.S. Application Data

(60) Provisional application No. 60/108,251, filed on Nov. 13, 1998.

(51) **Int. Cl.**[7] **H05K 3/32**

(52) **U.S. Cl.** **29/739**; 29/729; 29/757; 29/759; 361/685; 361/727

(58) **Field of Search** 361/683, 684, 361/685, 686, 724, 725, 726, 727; 29/729, 739, 757, 759

(56) **References Cited**

U.S. PATENT DOCUMENTS

4,754,397	6/1988	Varaiva et al. .	
4,988,308	1/1991	Toedtman .	
5,136,466	8/1992	Remise et al. .	
5,212,681	5/1993	Bock et al. .	
5,333,097	7/1994	Christensen et al. .	
5,621,890	4/1997	Notarianni et al. .	
5,721,669 *	2/1998	Becker et al.	361/685
5,816,673	10/1998	Sauer et al. .	

* cited by examiner

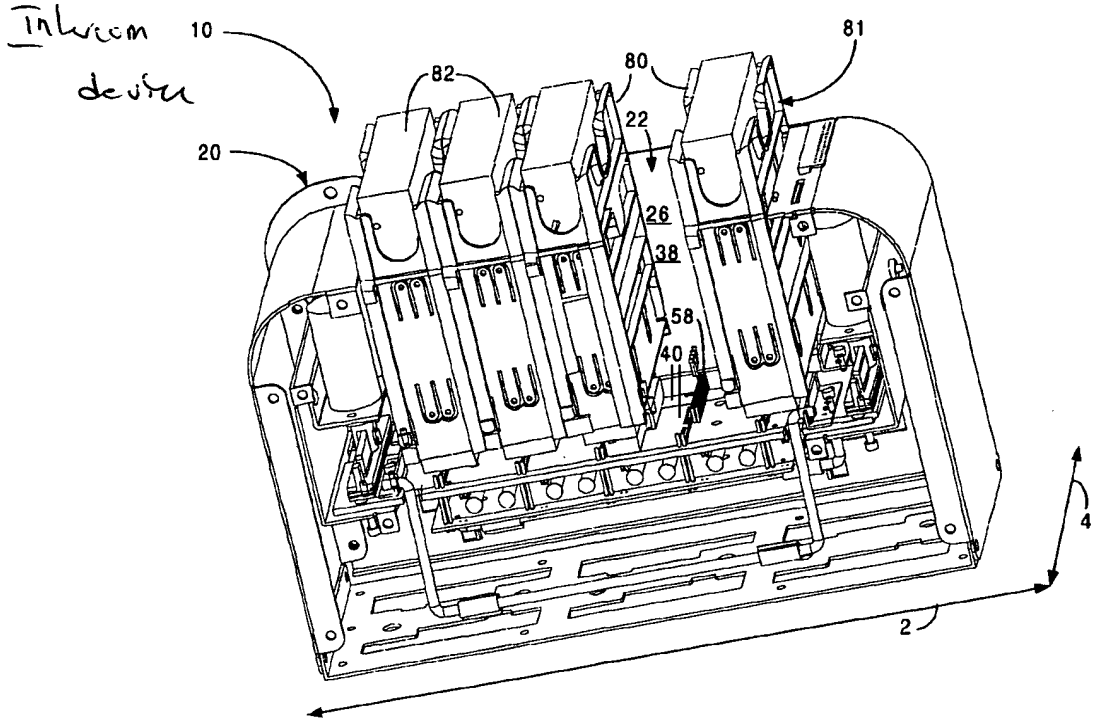
Primary Examiner—Lee Young
Assistant Examiner—Rick Kiltae Chang
(74) *Attorney, Agent, or Firm*—Larry B. Guernsey; Hickman Coleman & Hughes, LLP

(57) **ABSTRACT**

An apparatus (**10**) for aligning device interconnections, which includes a structure (**20**) having at least one reference plane (**38, 39**). The structure (**20**) further includes a number of device bays (**22**). The apparatus (**10**) also includes at least one interconnect assembly (**40**), and at least one clamp (**71**) for locking the interconnect assembly (**40**) in fixed spatial relation to the reference plane (**38**). A clamp release (**72**) is provided for releasing the clamp (**71**) so that the interconnect assembly (**40**) is free to move with respect to the reference plane (**40**). A positioning guide (**98**) is provided for positioning the interconnect assembly (**40**) at an appropriate location with respect to the at least one reference plane (**38, 39**) for proper alignment while the clamp (**71**) is released, before again being clamped in a fixed position with respect to the reference plane (**38**).

A method for aligning device interconnections is also disclosed.

15 Claims, 9 Drawing Sheets



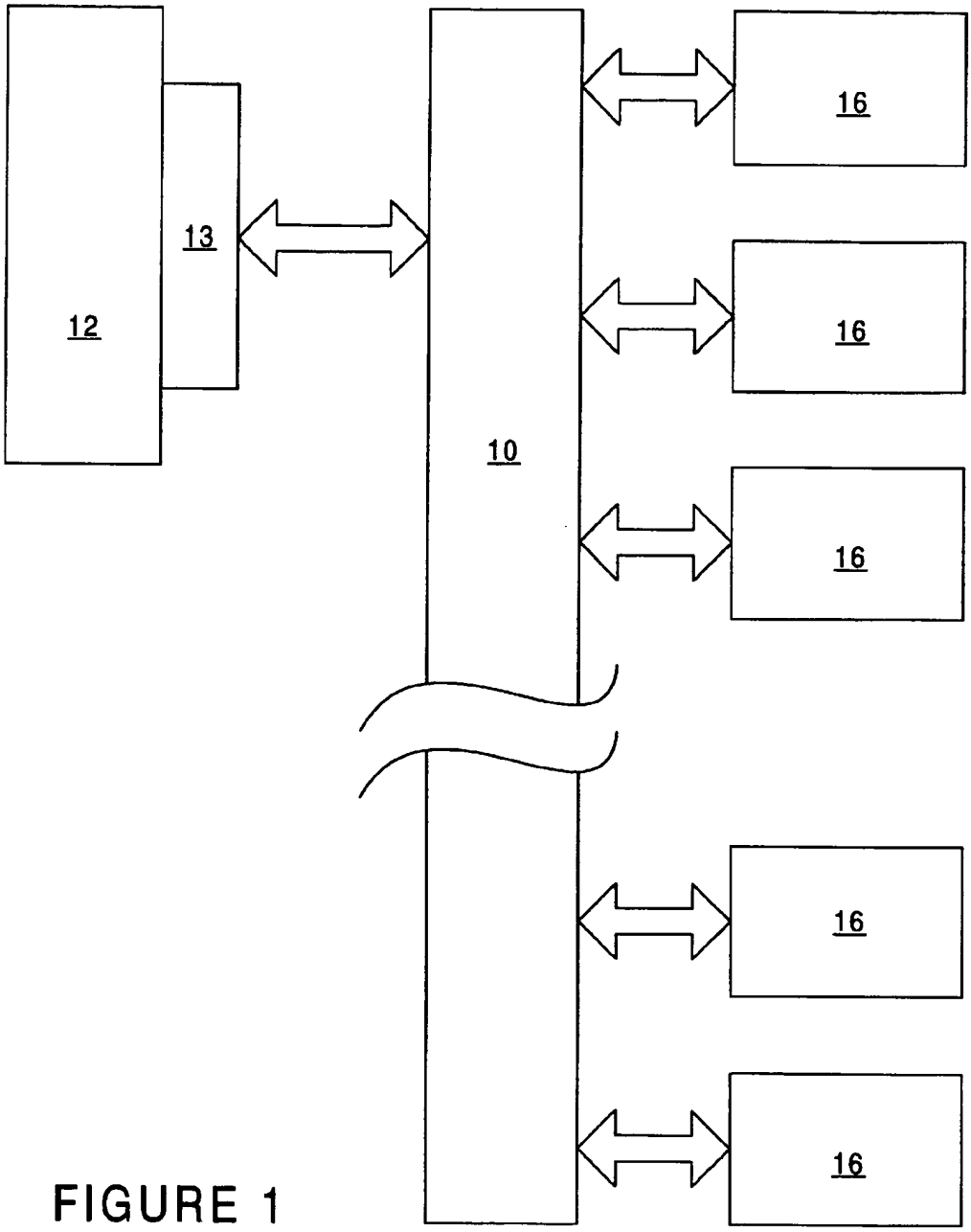


FIGURE 1

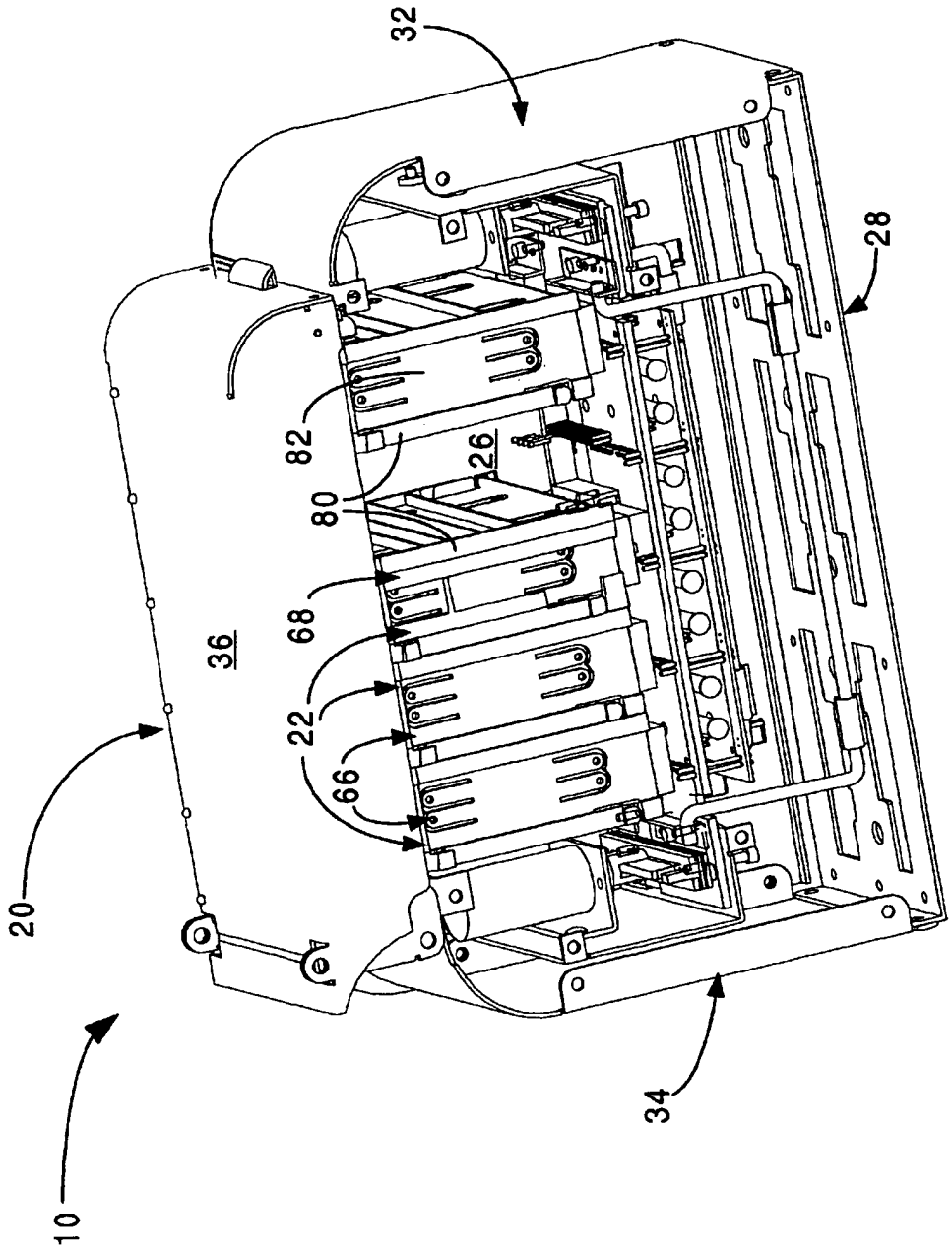


FIGURE 2

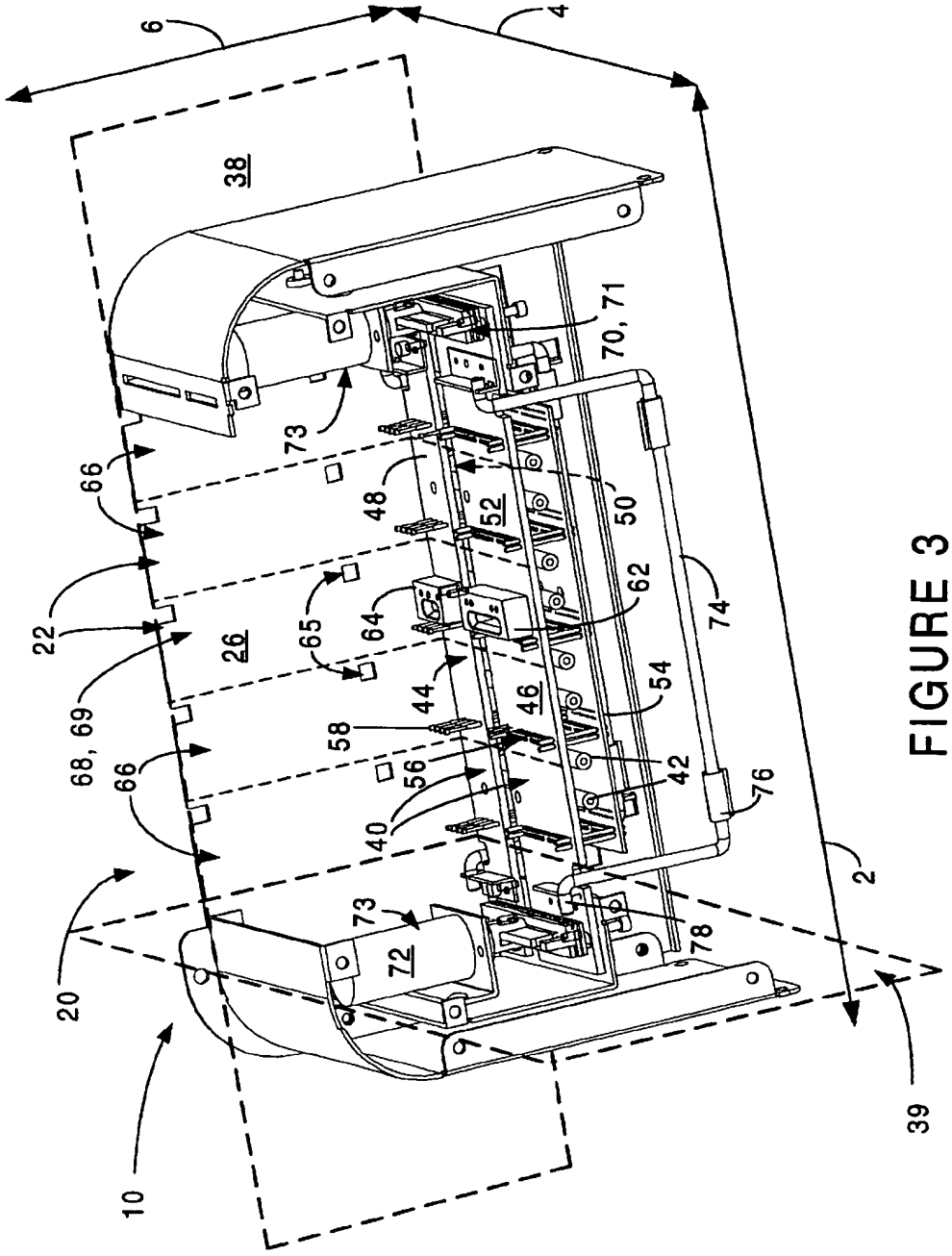

6
4
38
70, 71
73
66
48
52
50
22
26
65
64
62
74
68, 69
44
46
54
58
56
42
66
76
40
2
73
72
78
20
10
39

FIGURE 3

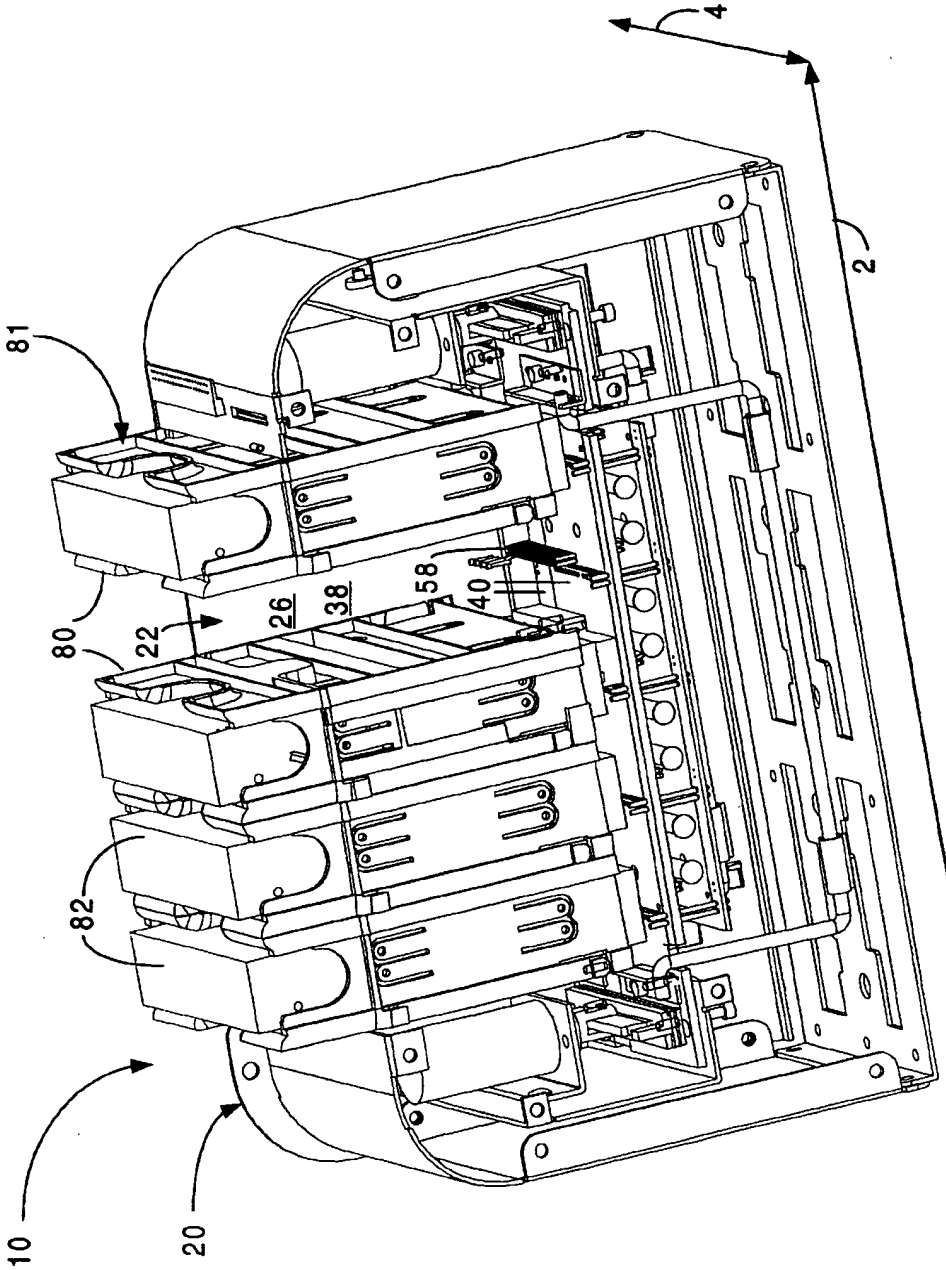


FIGURE 4

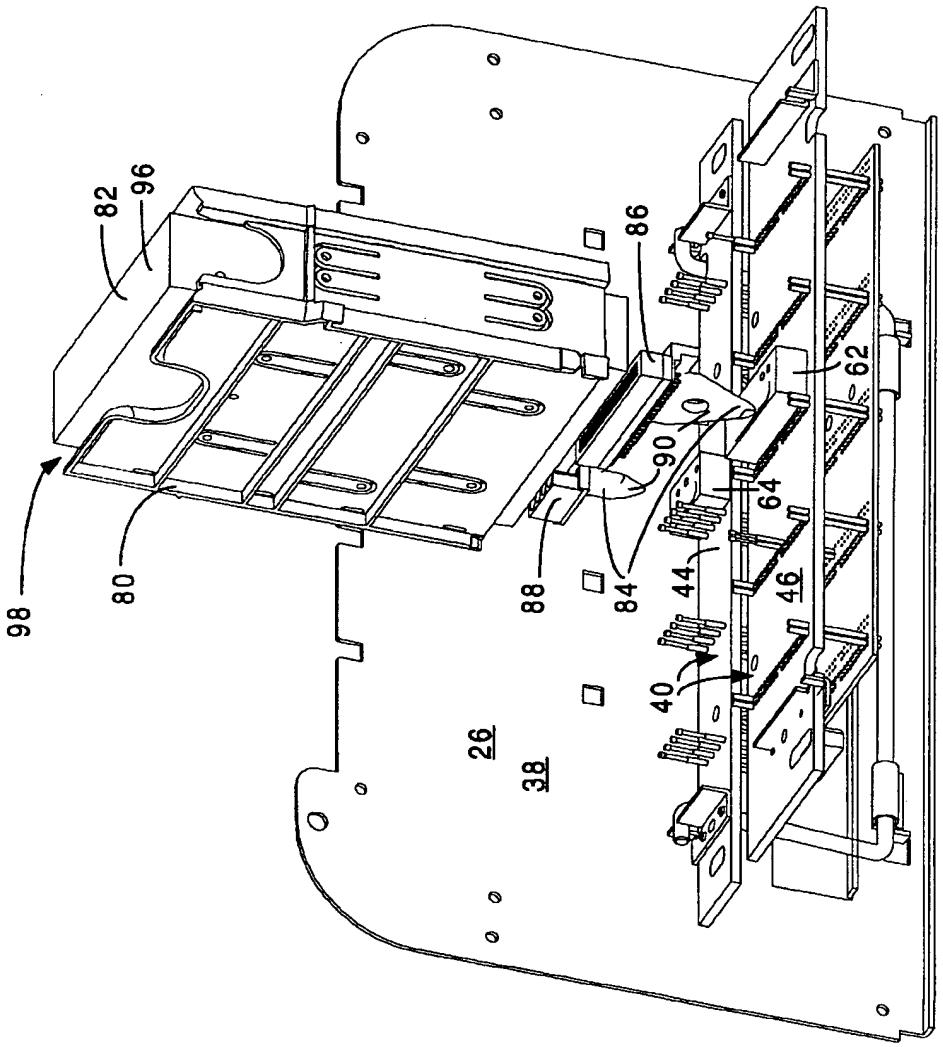


FIGURE 5

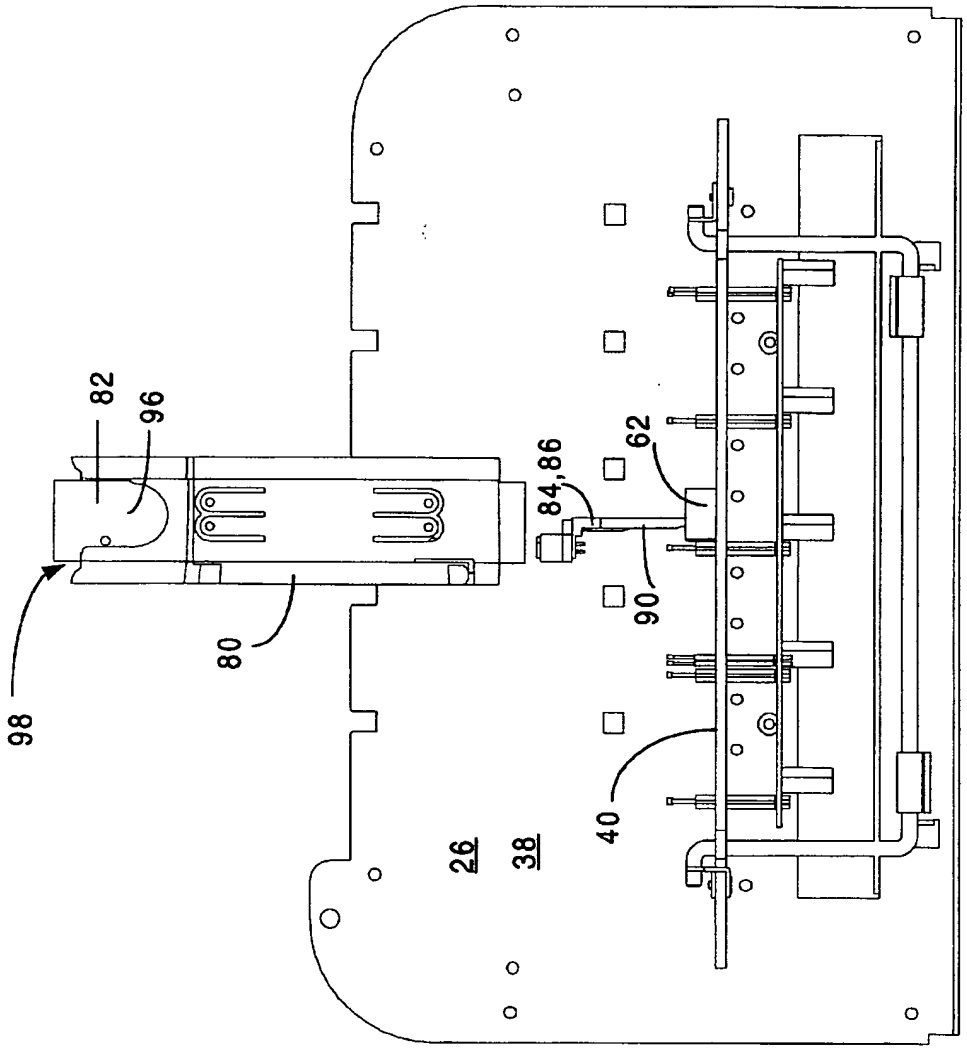


FIGURE 6

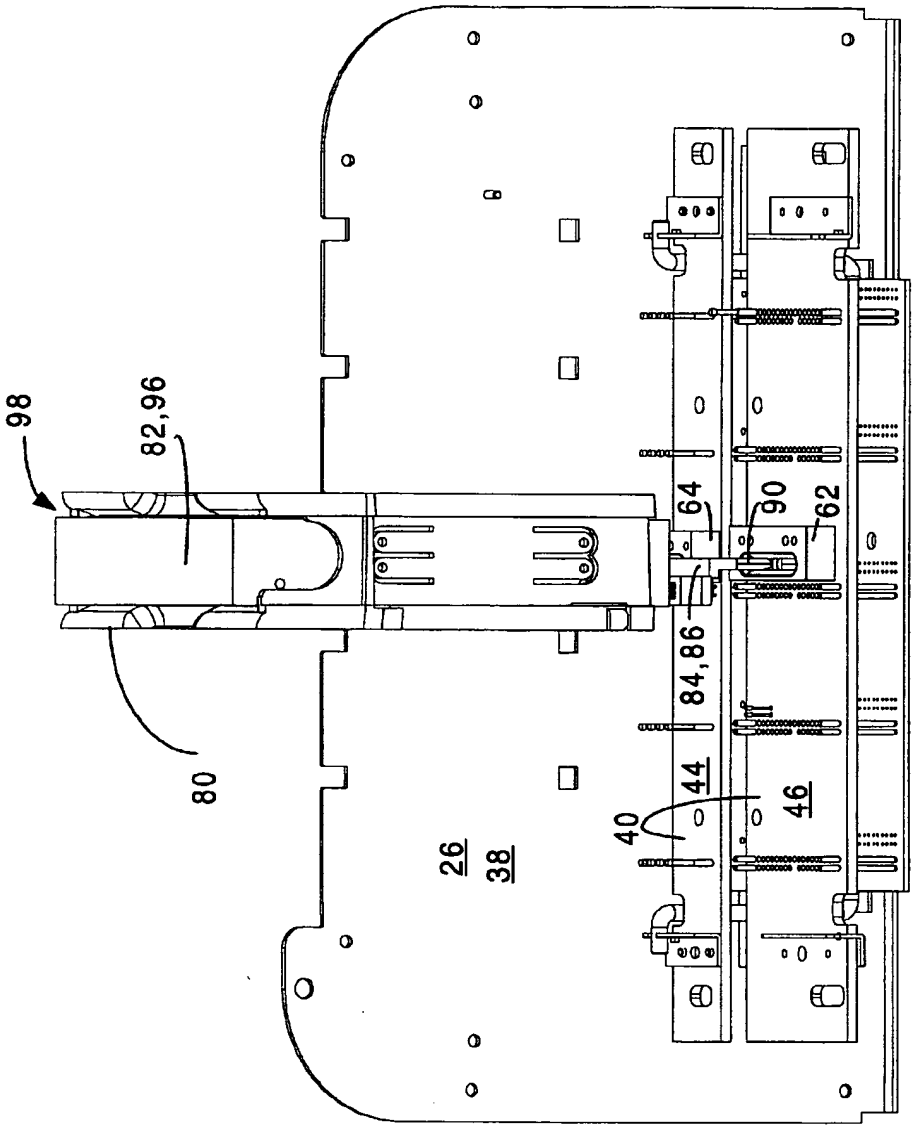


FIGURE 7

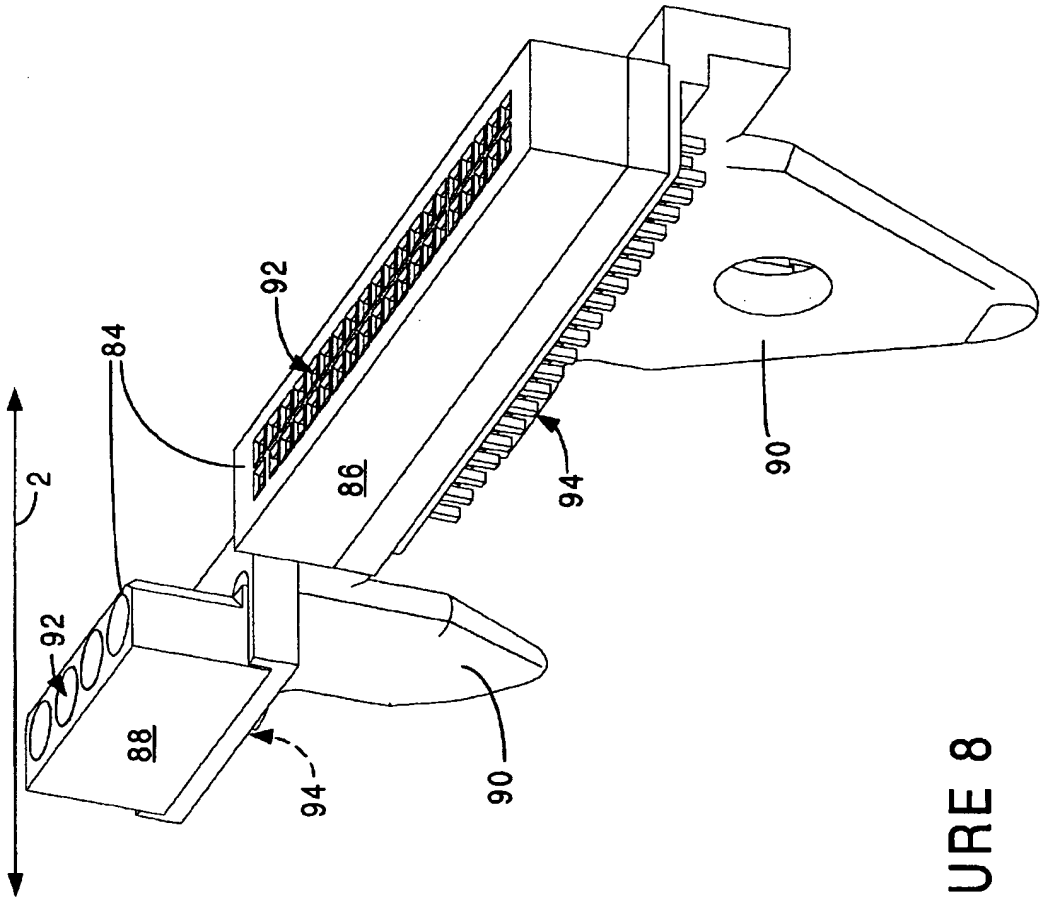


FIGURE 8

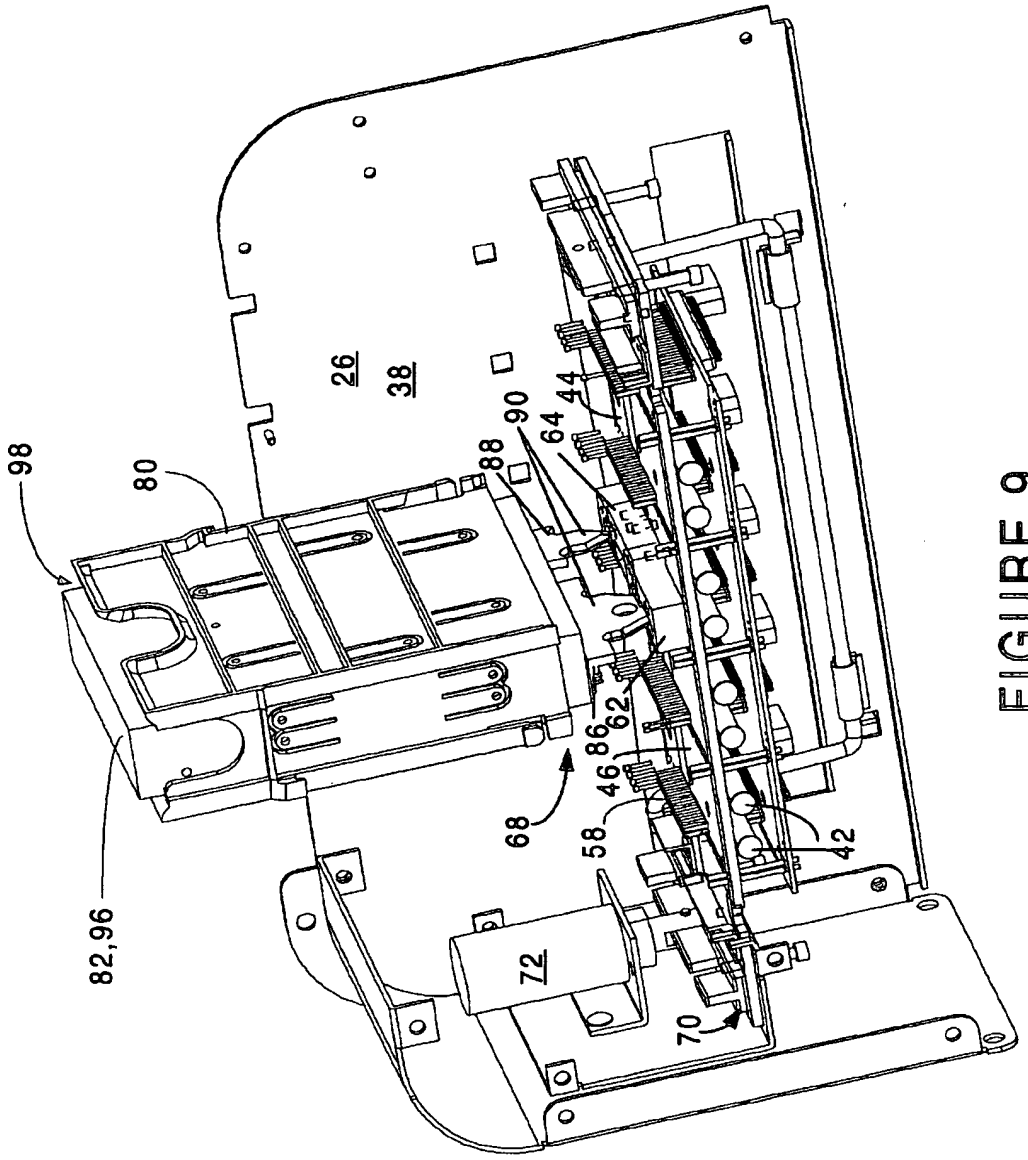


FIGURE 9

APPARATUS FOR ALIGNING DEVICE INTERCONNECTIONS

This application claims priority from U.S. Provisional Application Ser. No. 60/108,251, filed Nov. 13, 1998, which has the same inventor as the present application.

TECHNICAL FIELD

The present invention relates generally to alignment fixtures used in electronic testing and more particularly to duplication of software onto multiple storage devices. The inventor anticipates that primary application of the present invention will be in aligning device interconnectors for pre-installing software on an array of hard drives from one master hard drive. However, the present invention is also well suited to use in aligning device interconnectors for other manufacturing, testing, and end use applications where a repetitive interconnection of an electronic device or module gives rise to the same or similar problems common to this requirement. Applications such as the testing of electronic devices, and uploading/downloading of data from individual devices to a common electronic system or network of systems are examples.

BACKGROUND ART

Although there are certain general conventions concerning the configuration of interconnectors in electronic devices, there are still variations which exist from manufacturer to manufacturer. In particular the locational placement of power and signal connections to the devices are subject to much variation. To some extent, variations in location when making device interconnections have been dealt with by the use of flexible cables, which can be attached to connectors in varying spatial locations within the reach of the cable length, assuming the configuration of pins in the male portion align correctly with the corresponding female sockets. Each cable then must be manually guided to the correct position and pressed into position, taking care that the approach angles are within certain limits such that the connector pins are not bent in the process.

This works adequately for applications where few devices are used or the devices are expected to remain attached with infrequent subsequent replacements. However, for applications where devices are plugged and unplugged repeatedly, as when large lots of devices are tested, or are connected for data transfer or software imaging, this manipulation of cables is cumbersome and time intensive. For these kinds of high-repetition applications, a more suitable method would be to use connectors which allow the devices to be installed into a multiple device array structure. The connectors would be stationary, perhaps mounted on a common backplane, so that very minimal manipulation is required, and perhaps the process could even be automated. Unfortunately, the variations in position of the connectors from manufacturer to manufacturer make this impractical, as a backplane set up for one kind of device would not be usable for devices from a different manufacturer.

One example, which demonstrates the more general state of the industry, is the hard drive device, or HDD, as it will be referred to for brevity. The HDD adheres to a number of industry standards, including the MCC specifications which establish a matrix of length, width, and heights for various sizes commonly known as 3.5" full height, 3.5" half height, 2.5" full height, 2.5" half height, and so on. Mounting screw sizes and locations, as well as electrical connections, power, signaling, protocol, and more, are standardized within each

drive size class and sub-class, however the exact locations of the electrical connections were not standardized. All of the hard drives in the very popular sizes, such as those used by computer manufacturers, are reasonably similar in the placement of the external printed circuit board on the bottom surface of the design, and generally position the electrical connectors in a similar area.

The hard drives within a sub-class generally have the same number of electrical connections, for example 4 power contacts in a row of equal spacing and 40 signal contacts in 2 rows of consistent and equal spacing. They also have common dielectric contact housings which extend outward surrounding their respective power or signal contacts. It is practical therefore to consider all 4 power connections as a set with 1 positional location in relationship to external references. Similarly, all 40 signal connections are treated as a set in relationship to the external references. There are generally variations in the positional relationship of the power contact set with the signal contact set and both the power contact set and signal contact set vary in relationship to the external references of the hard drive assembly. Therefore attempting to make connections with a second type of device with a stationary backplane which has been configured for a particular first device type will most likely be unsuccessful.

Thus there is a need for an apparatus and method of interconnecting electronic devices which allow high repetition usage, which are adaptable to wide positional variation in power and signal connector sets, and which allows multiple units to be processed with minimal or no human manipulation.

DISCLOSURE OF INVENTION

Accordingly, it is an object of the present invention to provide a method and apparatus for aligning multiple electronic devices for quick insertion into an array box.

Another object of the invention is to provide an apparatus which can accommodate positional variations in the power and signal connections in electronic devices.

And, another object of the invention is to provide a device which uses interconnectors which have a higher cycle life than those found in standard connectors.

A further object of the present invention is to provide a method of performing high-speed software imaging on as many as 10 storage devices at once.

Yet another object of the present invention is to provide an apparatus and method by which connections are easily and conveniently made so that processing time is reduced.

A still further object of the present invention is to provide a spring pin contact set for power connections which is independent in position from the spring pin set for the signals.

Additionally, an object of the present invention is that the respective spring pin sets are positioned independently of the mechanical guides used to locate each device.

Briefly, one preferred embodiment of the present invention is a method and apparatus for aligning multiple device interconnections which includes a structure having at least one reference plane. The structure further includes a number of device bays. The apparatus also includes at least one interconnect assembly, and at least one clamp for locking the interconnect assembly in fixed spatial relation to the reference plane. A clamp release is provided for releasing the clamp so that the interconnect assembly is free to move with respect to the reference plane. A positioning guide is pro-

vided for positioning the interconnect assembly at an appropriate location with respect to the one or more reference planes for proper alignment while the clamp is released, before again being clamped in a fixed position with respect to the reference planes.

An advantage of the present invention is that by using spring contact connectors cycle life is expanded from 200–300 cycles in a conventional connector, to tens of thousands of cycles.

Another advantage of the invention is the manual connector plugging process of cables is eliminated.

And, another advantage of the invention is the time required to establish power and signal connections is reduced by approximately 90%.

A further advantage of the present invention is that large multiples of electronic devices can be simultaneously processed.

A yet further advantage of the present invention is that scrap damage costs are reduced since the use of easily bent connector contacts is eliminated.

A still further advantage of the present invention is that there is no need to keep multiple pin interconnect systems at hand which are each separately configured for a specific brand and model of electronic device. The present invention is adaptable to wide variations in power and signal connectors.

An additional advantage of the present invention is that devices without built-in guides or lead-in features can be aligned.

These and other objects and advantages of the present invention will become clear to those skilled in the art in view of the description of the best presently known mode of carrying out the invention and the industrial applicability of the preferred embodiment as described herein and as illustrated in the several figures of the drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

The purposes and advantages of the present invention will be apparent from the following detailed description in conjunction with the appended drawings in which:

FIG. 1 illustrates a block diagram of a data transfer system utilizing the present invention;

FIG. 2 shows a front perspective view of the present invention with the front wall removed for ease of viewing;

FIG. 3 illustrates a front perspective view of the present invention with the front wall, door, bottom wall, devices and carriers, and spring pins removed for ease of viewing;

FIG. 4 shows a front perspective view of the present invention with the front wall and door removed for ease of viewing;

FIG. 5 illustrates a partial front perspective view of the present invention, showing the installation of one sample device;

FIG. 6 shows a partial front plan view of the present invention showing the installation of one sample device;

FIG. 7 illustrates a partial front view of the present invention showing the installation of one sample device;

FIG. 8 illustrates a detail perspective view of the alignment plugs of the present invention; and

FIG. 9 shows a partial front perspective view of the present invention, showing the installation of one sample device.

BEST MODE FOR CARRYING OUT THE INVENTION

A preferred embodiment of the present invention is an apparatus for aligning multiple electronic device interconnects. As illustrated in the various drawings herein, and particularly in the view of FIG. 2, a form of this preferred embodiment of the inventive device is depicted by the general reference character **10**. The present invention **10** is especially useful for duplicating software packages such as the pre-installed software sold with new computer systems. Such new computers may have multiple programs, such as the operating system and various utility programs installed all at the same time on the computer's hard drive to insure proper integration and interaction. The installation of such integrated packages is called "imaging" and can be accomplished at very high speeds on multiple computers by reading the "master" image from one "master" hard drive and then transferring this image to a number of "slave" hard drives. The present invention is very useful for providing the interconnections to the slave devices as the slaves are inserted into the invention for imaging, and then removed.

FIG. 1 shows a block diagram of a system which uses the present invention with a master device **12** connected to a plurality of slaves **16** through a module **13** containing electronics providing the image duplicating circuitry and software to the present invention **10**. The connections shown are depicted as being two-way by using a two-headed arrow. In the application where software is being duplicated by imaging, these connections are generally one-way, and would be more properly shown as one-headed arrows from the master **12** to the interconnection device **10** and then to the slaves **16**. However, the present invention may also find application where a number of portable devices **16** such as pen based computers or notebook computers are used to collect data which is then transferred to a central computer **12** having a module **13** with electronics and software for receiving data through the interconnection device **10**, in which case the arrow directions would be reversed. Thus, doubled headed arrows are used to emphasize the potential for either type of application using the present invention **10**. The master device **12** could also be a stand-alone computer, or a network source.

As seen in FIG. 2, the present invention **10** provides a structure **20** having a plurality of device bays **22** having device guides **80** into which electronic devices **82** may be inserted. The structure **20** in the preferred embodiment is generally shaped as a six sided box having a rear wall **26**, a bottom wall **28**, a front wall (not visible, **30**), which has been removed from this view, a front endplate **32**, a rear endplate **34**, and a door **36**. The structure **20** is not necessarily an enclosed box, and could easily be formed as an open-sided rack or framework as long as the necessary reference planes, discussed below, are included. However, an enclosed structure may have advantages as to keeping the devices clean, or shielding them from environmental factors.

FIG. 3 shows a structure **20** from which the front wall, bottom wall and door have been removed, as well as all of the electronic devices. For ease of reference, a longitudinal axis **2**, a transverse axis **4** and a depth axis **6** have been illustrated, the longitudinal axis **2** being parallel to the length dimension of the rear wall **26**, the depth axis **6** being parallel to the height dimension of the rear wall **26**, and the transverse axis **4** being normal to the plane of the rear wall **26**. As will be discussed below, the rear wall **26** in this embodiment acts as a positional reference for device alignment, and thus also acts as a first reference plane **38**.

Two interconnect assemblies **40** are shown which are supported on a plurality of support members **42**, which in this embodiment are shaped as tubes or rods aligned generally with the transverse axis **4** and thus are generally normal to the rear wall **26**. In the preferred embodiment, the

interconnect assemblies **40** have been separated into an independent power supply interconnect assembly **44** and a signal interconnect assembly **46**. This separation is done to accommodate devices in which there are variations in the positioning of the set of power connectors relative to the positioning of the signal connectors. It is to be understood that if positional variations between the sets of power and signal connectors were small for a family of drives, or for applications that use just one combined power and signal interconnector set, such as are found on 2.5" hard drives, it is possible to have only one interconnect assembly. The present invention contemplates and encompasses any such variations.

Each interconnect assembly **40** is composed of two flat dielectric panels, preferably printed circuit boards, which form a top panel and a bottom panel. In the preferred embodiment, there are therefore a power supply top panel **48**, a power supply bottom panel **50**, a signal top panel **52** and a signal bottom panel **54**. The signal top panel **52** rests on the support members **42**. In the example shown, which is designed with five bays **22** (the approximate boundaries of which are illustrated by dashed lines), the signal top panel **52** has five sets of hole patterns **56** which replicate the signal contacts of the device for each of the five bays **22**. The five sets of hole patterns **56** are precisely spaced apart in the direction of the longitudinal axis **2** to match the spacing of the five device bays **22**. Assembled and secured into these holes are the spring pin assemblies **58** (not visible in this view) intended to make the electrical connections with the devices. The signal bottom panel **54** also contains the identical hole patterns **56** and is secured to each of the protruding bottom ends of spring pin assemblies. In this preferred embodiment, the panels **52, 54** are made of printed circuit boards, and the five sets of hole patterns in the signal bottom panel **54** are secured to the spring pin assemblies by soldering them into plated through holes in the panel **54**. There are also another five sets of plated through holes in the signal bottom panel **54** which are individually electrically connected to the first five sets of holes. Standard electrical connectors are soldered into these five sets of holes. Then electrical cable assemblies are connected on one end to each of the five standard electrical connectors. The other end of the five cable assemblies are then electrically connected to exposed electrical connectors protruding from the electronic imaging circuitry (not shown). The use of a flexible cable or flex circuit between the box structure connectors and the signal bottom panel **54** connectors enables the limited horizontal movement of the signal interconnect assembly **46**.

The power interconnect assembly **44** for connecting power to the devices is constructed in a manner similar to the signal interconnect assembly **46** with the power top panel **48** resting on the support members as well.

The signal top panel **52** also contains one or more signal alignment sockets **62**, and the power supply top panel has a similar one or more power supply alignment sockets **64**, which will be discussed below.

The interior space of the structure **20** has been divided with dashed lines to illustrate the approximate extent of the bays **22**, which are of two types. The majority of the bays are duplication bays **66**. The bay or bays which have the power and signal alignment sockets **62, 64** within their extent are used for both duplication and alignment of the power and signal interconnect assemblies **44, 46**, and are described as dual-purpose bays **68**. In the preferred embodiment, there is only one power alignment socket **64** and one signal alignment socket **62**, and thus one dual-purpose bay **68**. It is also possible that one or more dedicated bays be used only for alignment, and not for duplication, although this is naturally less efficient. A bay used for alignment, whether used as a dedicated bay or a dual purpose bay shall be termed an alignment bay **69**, and thus all dual purpose bays **68** are a kind of alignment bay **69**. The bay shown in FIG. **3** has both element numbers **68** and **69** associated with it, although an alignment bay **69** which is not intended to be used also as a dual purpose bay **68** would generally not have spring pins included.

A second reference plane **39** is also shown in FIG. **3** which is parallel to the transverse axis **4** and the depth axis **6**. The second reference plane **39** is, in the preferred embodiment, normal to the first reference plane **38**, although other orientations are possible. The second reference plane **39** can be fixed at any position along the longitudinal axis **2** and then used to locate the positions of the spring pin assemblies **58**, alignment sockets **62, 64** or other reference features. In particular, the preferred embodiment of the present invention has rectangular cut-outs **65** in the rear wall **26** which serve to precisely position device guides **80** (see also FIG. **2**) longitudinally with respect to the second reference plane **39** and thus define the longitudinal spacing of the five bays **22**. The second reference plane **39** is shown in FIG. **3** as being defined at the left-hand end of the left-most bay **66**. The boundaries of the bays **22** shown in dashed lines can then be thought of as a series of parallel reference planes, all parallel to second reference plane **39**. For ease of discussion, however, these parallel reference planes will not be illustrated, and all dimensions will be assumed to be directed from the first and second reference planes **38, 39**.

Also seen in FIG. **3** are clamp assemblies **70** and solenoids **72**. The clamp assemblies **70** include springs which bias the clamps **71** to press on the power and signal interconnect assemblies **44, 46** and hold them in position. The solenoids **72**, when activated act as clamp releases **73**, to release the clamps **71** and allow the power and signal interconnect assemblies **44, 46** to "float" on the support members **42**, generally in a plane defined by the longitudinal axis **2** and the transverse axis **4**, within a limited travel area.

The preferred embodiment optionally has one or more control arms **74** which are attached to the front wall **30** (not shown in this view) and rear walls **26**, by clips **76** which allow rotation about an axis parallel to the longitudinal axis **2**. The control arms ends **78** are attached to links on the interconnect assemblies **40**, and ensure that movement of the interconnect assemblies **40** when floating, is confined to translational movement in the transverse axis **4**, and longitudinal axis **2** directions, and that skew is minimized. The interconnect assemblies **40** are thus constrained to remain parallel to the first reference plane **38**.

In FIG. **4**, the front wall and door have been removed for easier visibility. Four of a potential total of five device guides **80** are shown positioned in the bays **22**. Each of the guides **80** is shown holding an electronic device **82**, in this case, a hard drive device. One of the guides **80** has been removed to allow view of the interconnect assemblies **40** and the spring pin assembly **58**. The device guides **80** are preferably made of molded plastic, and are secured to the front wall **30** (not visible in this view) and rear wall **26**, of the structure **20**. The device guide **80** in this preferred embodiment is a four sided shape containing an array of springs (not visible) on two adjacent walls, and otherwise smoothly sliding surfaces on the other two adjacent side walls. The device guides **80** are oriented during assembly such that the two adjacent smooth sliding surfaces are accurately positioned transversely with regard to the first reference plane **38**, in this case, the rear wall **26**, and the

second smooth sliding surface is accurately positioned longitudinally for each bay **22** with regard to the second reference plane **39** (see FIG. 3). The device guides **80** are open on the top and bottom. When devices **82** are inserted into the guides **80**, the springs will be displaced thereby imparting a force against two surfaces of the device **82**. The device **82** then is forced against the smooth sliding surfaces of two adjacent interior side walls of the guide **80**. The alignment of these smooth sliding surfaces with the reference planes **38, 39** assures that the devices **82** will be held in a consistent spatial relationship to each other, being parallel to the longitudinal axis **2** and transverse axis **4**. The device guide **80** is an example of a biasing device **81**, of which there can be many varieties. The purpose of the biasing device **81** will be to ensure that connectors on the devices **82** will all be in a consistent spatial relationship to the signal and power interconnect assemblies **46, 44**.

The biasing device **81** can be one or more springs (not shown) which urge each device **82** into a consistent spatial relationship with the reference planes **38, 39**, whether used in a fixture such as a device guide **80**, or not. The biasing device **81** can also be as simple as a shelf or series of shelves (not shown) against which a device **82** is to be pressed manually or by an automated handler as each device **82** is placed in a device bay **22**. The biasing device **81** could take advantage of gravity as a way of urging the device **82** against the reference planes **38, 39** by orienting one or more shelves so that a device naturally falls against the appropriate surface.

FIGS. **5, 6** and **7** illustrate partial views, containing the rear wall **26**, which serves as the first reference plane **38**, with the interconnect assemblies **40** from which the spring pin assemblies have been removed for easier visibility. Also shown are a device guide **80**, holding a device **82**, which has been chosen as a sample to align the interconnect assemblies, and therefore the device is designated as a sample device **96**. The sample device **96**, together with the device guide **80**, acts as a positioning guide **98**. Alignment plugs **84**, which mate with the connectors in the sample device, in this case are of two types, a signal connector alignment plug **86** and a power alignment plug **88**. The signal and power alignment plugs **86, 88**, are inserted into the corresponding connectors on the device **96**, and then the tips **90** of the signal and power alignment plugs **86, 88**, are inserted into the corresponding signal alignment socket **62** and power supply alignment socket **64**. FIGS. **6** and **7**, which shows partial front views of the same elements as FIG. **5**, illustrate the offset nature of the alignment plugs **84**.

FIG. **8** shows a detail perspective view of the signal and power alignment plugs **86, 88**. The plugs **84** are fashioned with a receiving portion **92** into which the pins of the sample device are inserted. The alignment tips **90** are formed in a triangle or wedge shape and are offset in the longitudinal axis **2** direction a precise distance from the output pin array **94**, which is equal to the offset of the alignment socket **64** from the spring pin assemblies **54**.

FIG. **9** illustrates the positioning of a sample device **96** in a dual-purpose bay **68** when alignment is to be performed. The solenoid **72** is activated which allows the signal interconnect assembly **46** and power interconnect assembly **44** to float on the support members **42**. The signal and power alignment plugs **86, 88** have been inserted into the sample device **96** connectors. The tip **90** of the signal alignment plug **86** is inserted into the signal alignment socket **62**, and the tip **90** of the power alignment plug **88** is inserted into the power alignment socket **64**. The device guide **80** is aligned with the reference planes **38, 39** (see also FIG. 3), and the device **96** within the guide **80** is spring biased in alignment with the same reference planes **38, 39**. As the triangular or wedge-shaped tips **90** enter the signal and power alignment sockets **62, 64**, the tapered exterior profiles of the plugs **86, 88** engage the tapered inner profiles of the sockets **62, 64**. Lateral force generated as the plugs mate with the sockets causes the power alignment socket **64** and signal alignment sockets **62** to independently move the interconnect assemblies **46, 48**, into alignment with their respective alignment plugs **88, 86**. The control arms **74** restrain movement of the interconnect assemblies to longitudinal and transverse translation, thus positioning the spring pin assemblies **58** in alignment with all of the device guides **80**. The offset nature of the alignment plugs **84** allow this alignment process to occur in this dual-purpose bay **68**. Thus the dual-purpose bay **68** allows duplication as well as alignment.

After alignment has occurred, the solenoid **72** is deactivated, allowing the clamps **70** to again fix the positions of the interconnect assemblies **40**. This completes the alignment process. After the alignment, the alignment device **96** is removed, and the alignment plugs **86, 84** are removed from the device **96**, returning it to a standard device **82** configuration. All five bays **22** are aligned, and are now able to received devices **82**. Five devices **82** can now be inserted into the five guides **80** and complete the aligned electrical connections with the five sets of spring pins **54**. The alignment plugs **84** are removed from the sample device **96**, and stored. Alignment generally needs to occur only once for each type of devices having repeatable interconnect locations, thus the dual-purpose bay may thereafter function solely as a duplication bay, until there is a change to a different type of device which has differing interconnect locations.

As an optional variation, the structure **20** may be configured so that after the devices **82** are installed into the device guides **80**, the door **36** (see FIG. **2**), as it closes, forces the devices **82** down to compress the spring pin arrays **58** a repeatable distance to insure reliable connection. At this point, a control signal may be generated which initiates the duplication procedure.

It will be understood by those skilled in the art that many variations may exist in the positioning of the devices with respect to the reference plane. For instance, instead of device guides, the structure may be configured with shelves which have some biasing feature to keep the devices in a repeatable relation to the reference plane. Of course, there is no requirement that the rear wall serve as the reference plane, as any other spatial reference plane will serve.

Additionally, it will be obvious that the number of bays is not limited to five, and the alignment or dual purpose bay is not limited to a single, centrally located bay. Many more arrangements and configurations of the bays are contemplated including multiple rows of bays, a horizontal device loading arrangement, and multiple dual-purpose or alignment bays, the dual-purpose or alignment bays perhaps being positioned at either end of a long row of duplication bays. Such a configuration would allow for longer interconnect assemblies with greater numbers of duplication bays, since angular deviations are more easily rectified with a positioning guide at each end of a length, rather than a single central positioning guide.

Likewise, there are other variations of the clamping devices, the support members, and the control arms which will be obvious to one skilled in the art. A single panel construction of the interconnect assemblies is possible. Manual clamping and release of the interconnect assembly position is also possible.

A linkage assembly, rack and pinion arrangement, or a tensioned cable and pulley arrangement are all methods which can substitute for the control arm.

As referred to above, the applications of the present invention are not limited to high-speed imaging from a master device to an array of slaves. The data flow can be reversed, as where multiple portable devices input data to a host computer. The data flow may be two-way, and there may be a single interconnect assembly with combined power and signal connections, or two, three or more separate interconnect assemblies which are allowed to independently align with a sample device. It is also possible that the dual-purpose bay be only a dedicated alignment bay with no duplicating capability. Further, it is possible that alignment be performed without a sample device at all, but merely with a positioning template which has been fashioned to replicate the positions of the target device interconnects. It is also possible to implement the invention utilizing a manually positioned interconnect array in cooperation with a visual means to track the position of the array interconnectors in relationship to the chosen sample device interconnect positions. Such a method could be further augmented with a motorized positioning capability with position memory, and the capability to recall previous adjustment settings and repeatably re-position the interconnect assemblies by entering a code for a specific device and activating the system to reposition the interconnector assemblies accordingly.

In addition to the above mentioned examples, various other modifications and alterations of the inventive method and apparatus **10** may be made without departing from the invention. Accordingly, the above disclosure is not to be considered as limiting.

Industrial Applicability

Transfer of information and software from device to device has become very important in the modern age. With the proliferation of standardized operating systems and applications software for personal computers, it becomes more and more important that software packages, such as the pre-installed software sold with new computer systems, be easily and quickly transferred to the hard drives which are installed in new personal computers. To insure proper integration and interaction, such new computers may have multiple programs, such as the operating system and various utility programs, installed all at the same time on the computer's hard drive. The installation of such integrated packages is called "imaging" and can be accomplished at very high speeds on multiple computers by reading the "master" image from one "master" hard drive and then transferring this image to a number of "slave" hard drives. The present invention **10** is very useful for providing the interconnections from the master device **12** to the slave devices **16** as the slaves **16** are inserted into the invention **10** for imaging, and then removed. In addition, copies of data gathered from pen computers must be transferred to a central computer so that the data individually gathered can be compiled and correlated. The present invention **10** is very useful in making connections between these pen computers and the central computer.

The present invention **10** includes a reference plane **38** from which positional references are made, one or more electrical interconnect assemblies **40** and a number of device bays **22**. The one or more interconnect assemblies **40** are supported by a number of support members **42** and are free to float in a limited planar area unless fixed in place by one or more clamps **71**. The clamps **71** are held in place by springs which urge them to press upon the interconnect assemblies **40** unless a solenoid **72** or some other clamp release **73** mechanism is activated to release the clamps **71**. The majority of device bays **22** are single purpose duplication bays **66**. A positioning guide **98**, such as a sample electronic device **96** is fitted with one or more offset alignment plugs **86, 88** and is inserted into a dual-purpose bay **68** which has one or more alignment sockets **62, 64** mounted on the interconnect assemblies **40**. The sample device **96** is biased in some manner toward the reference planes **38, 39**, and the one or more alignment plugs **86, 88** mate with the corresponding one or more alignment sockets **62, 64** in the dual-purpose bay **68**. When the solenoid **72** is activated so that the interconnect assemblies **40** are free to float in the plane of the supports members **42**, the alignment plugs **86, 88**, as they mate with the alignment sockets **62, 64**, pull the interconnect assemblies **40** into an interconnect alignment parallel with the reference planes **38, 39**. When insertion of the sample device **96** has been accomplished, the solenoid **72** is deactivated and the clamps **71** prevent the interconnect assemblies **40** from further movement. Optionally, one or more control arms **74** are provided which help to restrain movement of the floating interconnect assemblies **40** to translations parallel and perpendicular to the reference planes **38, 39**, and prevent skew.

Once the alignment has been achieved, and device **96** removed, electronic devices **82** with similar connector locations can be easily and quickly inserted into the bays **22** and data transfer processes such as high-speed imaging can be performed. The bay with the sample device **96** is termed a dual-purpose bay **68** because the bay provides for offset alignment, while also allowing for electrical connections after alignment. Thus after serving to align the entire array of bays **22**, the sample device **96** can have data transfer performed in the same manner as the non-sample devices. After the initial alignment is done, device **96** is removed, and the alignment plugs **86, 88** are removed from it, rendering it as a standard device **82**. All five bays **22** including dual purpose bay **68**, are aligned, and are now able to receive devices **82**. The dual-purpose bay **68** then functions as a duplication bay **66**.

The present invention **10** is designed to accommodate positional variations in the power and signal connections in electronic devices and is adaptable to wide variations in power and signal connectors including those without built-in guides or lead-in features. Consequently, there is no need to keep multiple pin interconnect systems at hand which are each separately configured for a specific brand and model of electronic device. This reduces storage requirements and equipment costs.

The present invention **10** also allows the use of spring pins assemblies **58** as connection devices. Spring pins have a higher cycle life than those found in standard connectors. The inventor estimates that cycle life is expanded from 200–300 cycles in a conventional connector, to tens of thousands of cycles for spring pin assemblies. Scrap damage costs are also reduced since the use of easily bent connector contacts is eliminated in favor of more durable spring pins. Spring pins are also easier to connect, and the inventor estimates that the time required to establish power and signal connections is reduced by approximately 90%.

The present invention **10** can also easily be integrated into an automated system so that minimal or even no human manipulation is required, thus further reducing costs.

For the above, and other, reasons, it is expected that the present invention **10** and its method of use will have widespread industrial applicability. Therefore, it is expected that the commercial utility of the present invention will be extensive and long lasting.

What is claimed is:

1. An apparatus for aligning device interconnections of a plurality of electronic devices comprising:

a structure having at least one reference plane, said structure further including a plurality of device bays;

at least one interconnect assembly, operatively associated with said structure, for accepting connections from said plurality of electronic devices;

at least one clamp, operatively associated with said structure, for fixing said at least one interconnect assembly in fixed spatial relation to said reference plane;

clamp release, operatively associated with said structure, for releasing said at least one clamp so that said at least one interconnect assembly is free to move with respect to said reference plane; and

positioning guide, operatively associated with said structure, for positioning said at least one interconnect assembly at an appropriate location with respect to said reference plane for proper alignment while said clamp is released, before again being clamped in a fixed position with respect to said reference plane, said interconnect assembly then being held in fixed alignment for reception of connections from said plurality of electronic devices.

2. The apparatus for aligning device interconnects as in claim 1, wherein:

said at least one interconnect assembly includes at least one separate power supply interconnect assembly and at least one separate signal interconnect assembly.

3. The apparatus for aligning device interconnections as in claim 1, wherein:

said at least one interconnect assembly includes at least one spring pin assembly.

4. The apparatus for aligning device interconnections as in claim 1, wherein:

said structure includes at least one control arm which minimizes skew in a movement of the at least one interconnect assembly.

5. The apparatus for aligning device interconnections as in claim 1, wherein:

said clamp release is a solenoid.

6. The apparatus for aligning device interconnections as in claim 1, wherein:

said at least one interconnect assembly includes at least one alignment socket.

7. The apparatus for aligning device interconnections as in claim 6, wherein:

said positioning guide includes at least one alignment plug which engages said at least one alignment socket to direct alignment of said at least one interconnect assembly.

8. The apparatus for aligning device interconnections as in claim 7, wherein:

said at least one alignment plug is offset to allow the bay each one of said plurality of bays containing the alignment plug and socket to act as a dual purpose bay.

9. The apparatus for aligning device interconnections as in claim 1, wherein:

said device bays include at least one alignment bay.

10. The apparatus for aligning device interconnections as in claim 9, wherein:

said at least one alignment bay includes two alignment bays which are located at opposing ends of said at least one interconnect assembly.

11. The apparatus for aligning device interconnections as in claim 10, wherein:

at least one of said two alignment bays is a dual purpose bay.

12. The apparatus for aligning device interconnections as in claim 1, wherein:

said positioning guide is a sample device.

13. The apparatus for aligning device interconnections as in claim 1, wherein:

said positioning guide includes a device guide and a sample device.

14. The apparatus for aligning device interconnections as in claim 1, wherein:

said positioning guide is a template.

15. The apparatus for aligning device interconnections as in claim 1, further comprising:

at least one biasing device.

* * * * *

US006243273B1

(12) **United States Patent**
Beun et al.

(10) **Patent No.: US 6,243,273 B1**
(45) **Date of Patent: Jun. 5, 2001**

(54) **MINI-BACKPLANE "T" ASSEMBLY**

(75) Inventors: **Roger Arthur Beun**, Kanata (CA); **William Locke Craig, Jr.**, Durham, NC (US); **Joseph John Lommen**, Nepean (CA); **Janice Parker Broniak**; **Derek Chunchi Liou**, both of Cary, NC (US); **Jeffrey Scott Taylor**, Apex, NC (US)

(73) Assignee: **Nortel Networks Limited**, Montreal (CA)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

(21) Appl. No.: **09/388,366**

(22) Filed: **Sep. 1, 1999**

(51) **Int. Cl.**[7] **B65D 43/08**

(52) **U.S. Cl.** **361/796**; 361/788; 361/756; 361/704; 361/741; 361/796; 361/797; 439/325; 439/326; 439/327; 439/260; 439/261; 439/630; 439/631

(58) **Field of Search** 439/65, 325–328, 439/260–261, 267, 630–632; 361/788, 756, 796, 797, 727, 741, 704

(56) **References Cited**

U.S. PATENT DOCUMENTS

5,128,830	*	7/1992	Deluca et al.	361/383
5,411,416		5/1995	Balon et al.	439/639
5,757,617	*	5/1998	Sherry	361/685
6,104,613	*	8/2000	Urda et al.	361/704

OTHER PUBLICATIONS

International Search Report dated Dec. 5, 2000.

"High Capacity Lineup Dramatically Boosts Efficiency, Lowers Network Costs For Operators," Discovery, vol. 48, Fourth Quarter 1998, pp. 12–16, XP000667405, ISSN: 0780–3931.

Rosenlund, H., "The Base Transceiver Station (BTS) To Base Station Controller Interface A–bis," Proceedings of Digital Cellular Radio Conference, Oct. 1, 1998, XP000198903.

Carrie, A., Cellmer, J. and Marciguey, M., "MATRACOM 9200 ET AXE 10: Un système flexible pour les réseux GSM," Commutation et Transmission, FR, Sotelec, Paris, vol. 13, No. 1, 1991, pp. 5–18, XP000247526, ISSN: 0242–1283.

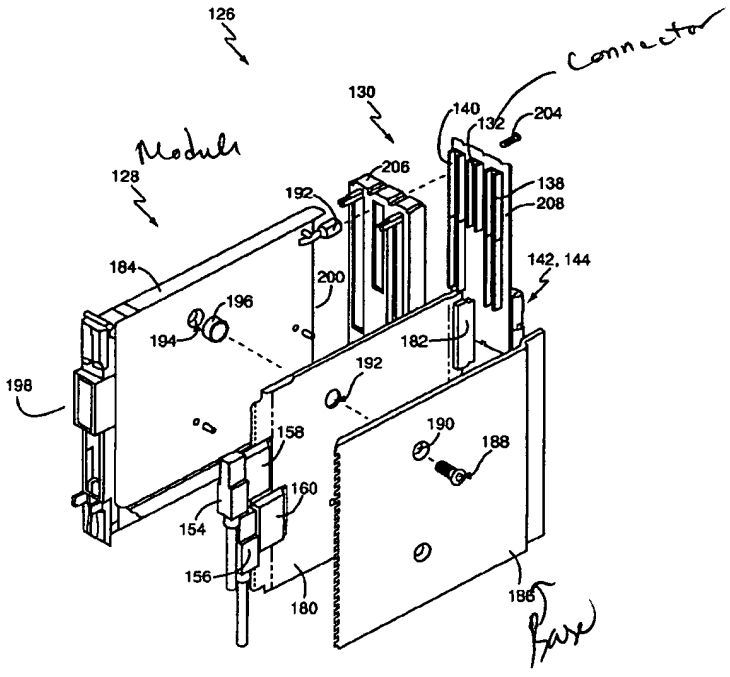
* cited by examiner

Primary Examiner—Jeffrey Gaffin
Assistant Examiner—Thanh Y. Tran
(74) *Attorney, Agent, or Firm*—Winthrow & Terranova, P.L.L.C

(57) **ABSTRACT**

Apparatus for mounting retrofit equipment modules into the equipment mounting cabinetry of an installed modular equipment signal network includes an interface module and mini-backplane combination which is adapted for insertion into the equipment cabinetry with electrical signal connection of the mini-backplane to the cabinetry master backplane, and for mounting retrofit modules inserted therein in electrical signal interconnectivity with others of the network equipment modules.

17 Claims, 7 Drawing Sheets



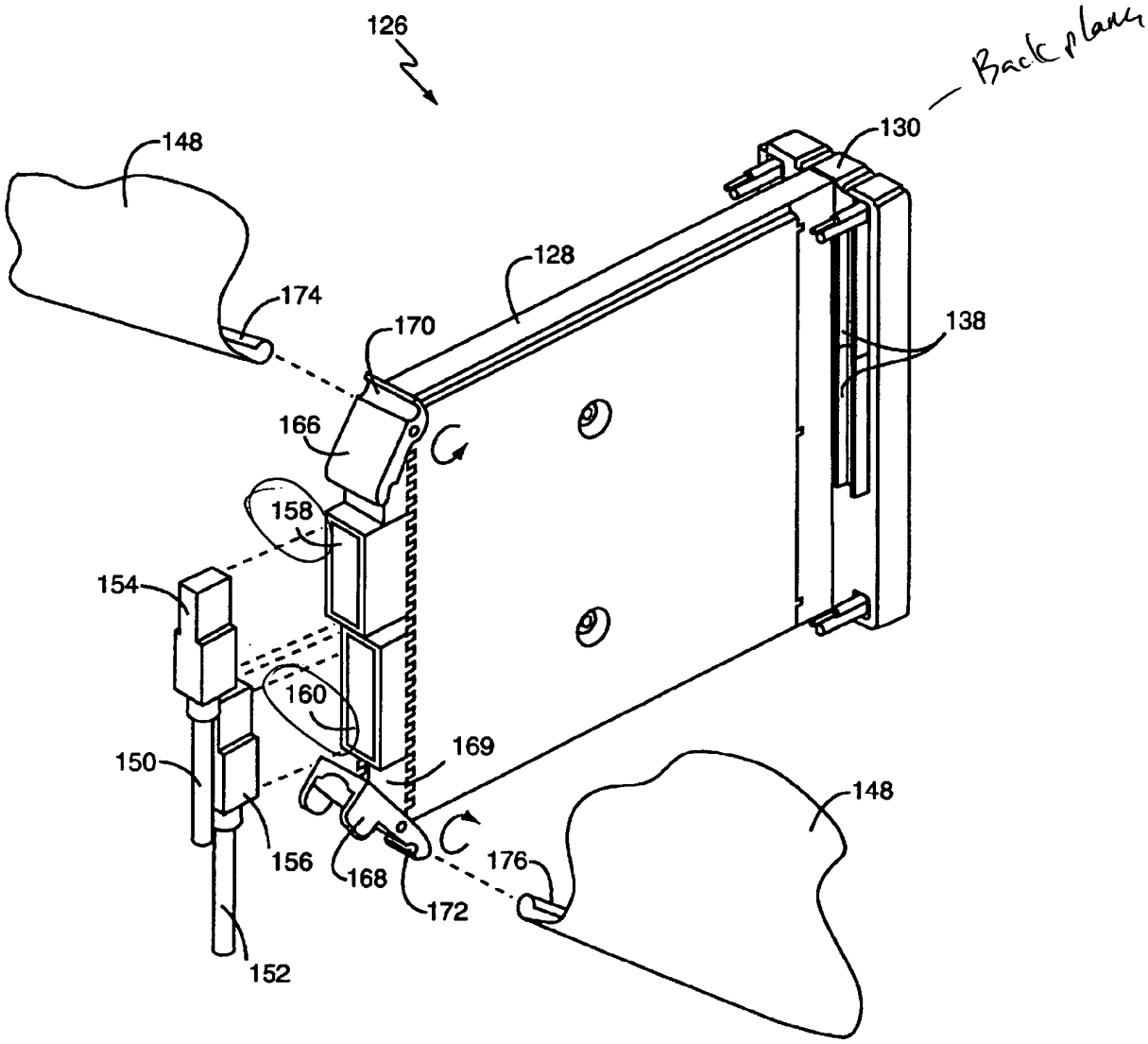

126
Back plane
130
148
128
174
170
138
166
158
154
160
169
150
148
156
168
176
172
152

FIG. 1

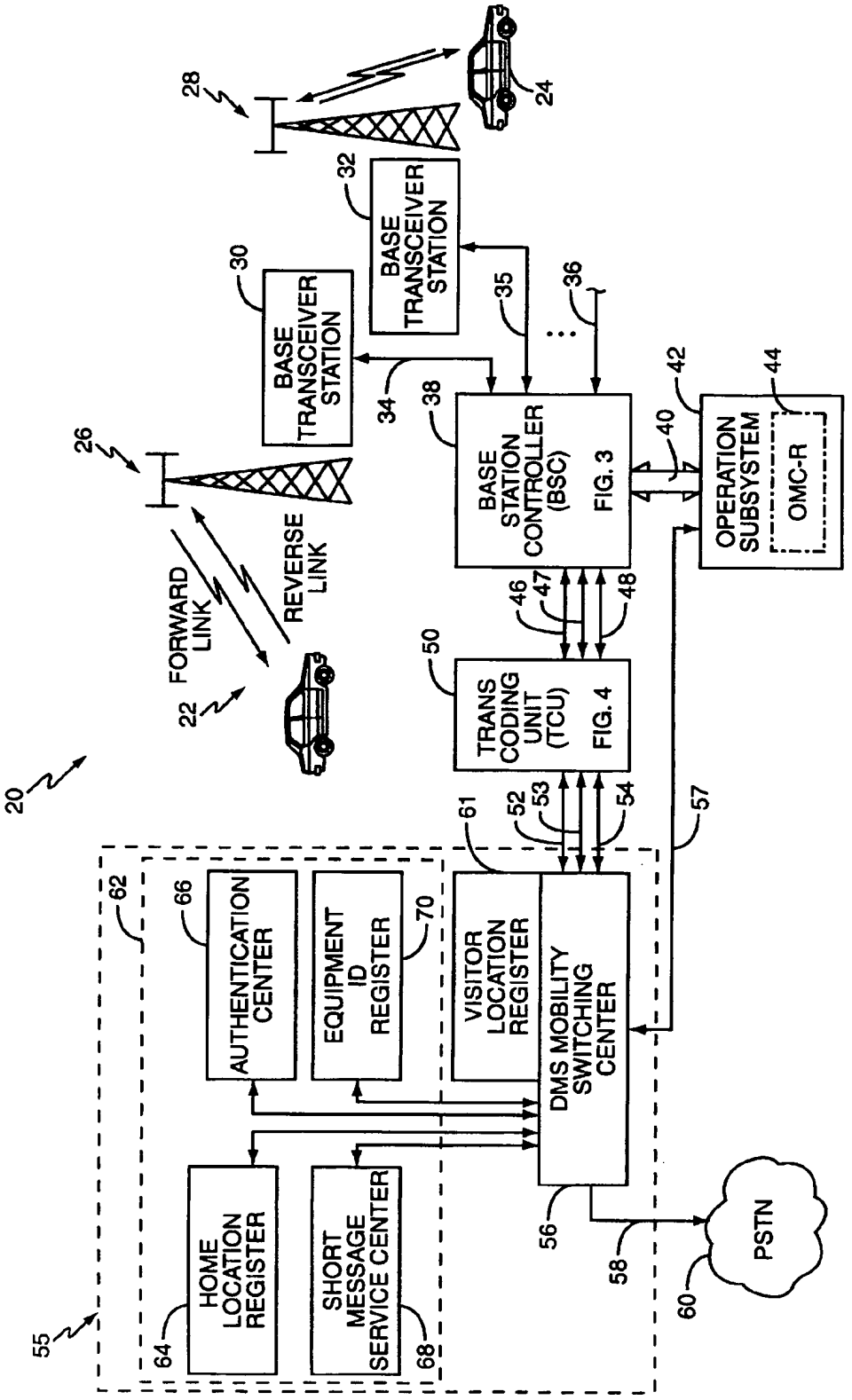

20
22
24
26
28
30
32
34
35
36
38
40
42
44
46
47
48
50
52
53
54
55
56
57
58
60
61
62
64
66
68
70
BASE TRANSCEIVER STATION
BASE TRANSCEIVER STATION
BASE STATION CONTROLLER (BSC)
FIG. 3
OPERATION SUBSYSTEM
OMC-R
FORWARD LINK
REVERSE LINK
TRANS CODING UNIT (TCU)
FIG. 4
AUTHENTICATION CENTER
EQUIPMENT ID REGISTER
VISITOR LOCATION REGISTER
DMS MOBILITY SWITCHING CENTER
HOME LOCATION REGISTER
SHORT MESSAGE SERVICE CENTER
PSTN

FIG. 2

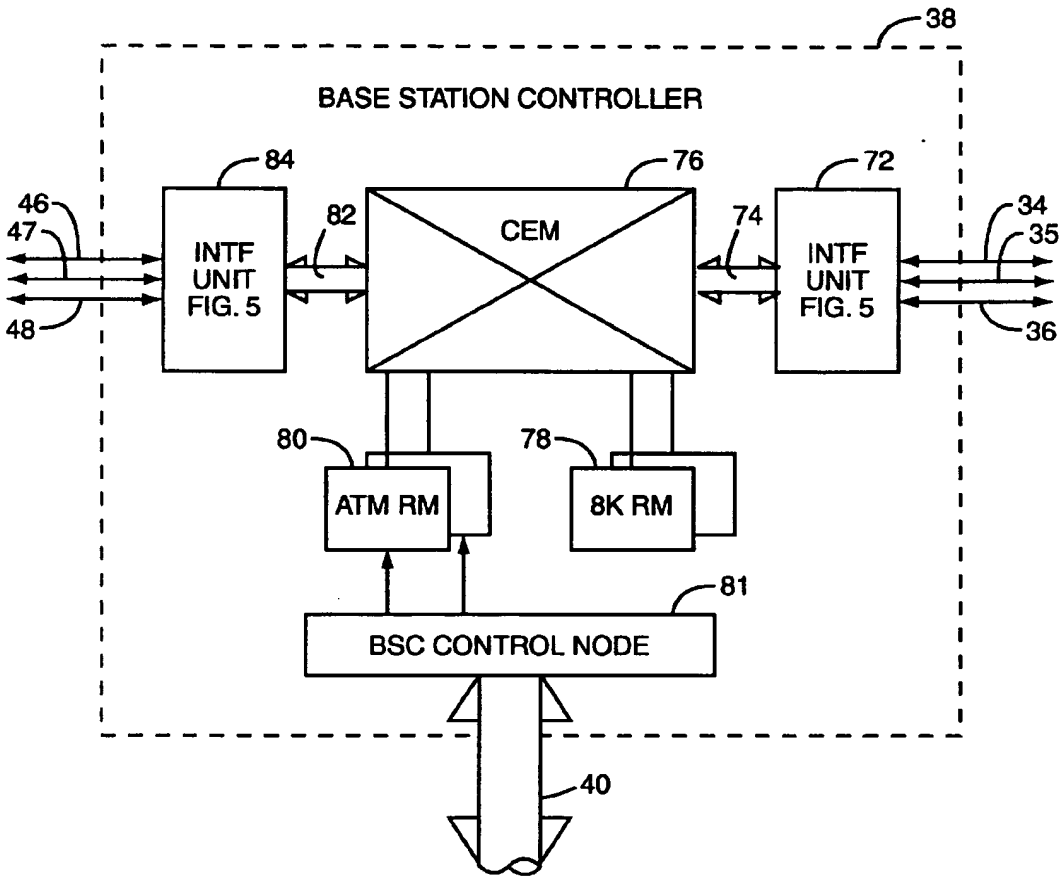

38
BASE STATION CONTROLLER
84
76
72
46
47
48
INTF UNIT FIG. 5
82
CEM
74
INTF UNIT FIG. 5
34
35
36
80
78
ATM RM
8K RM
81
BSC CONTROL NODE
40

FIG. 3

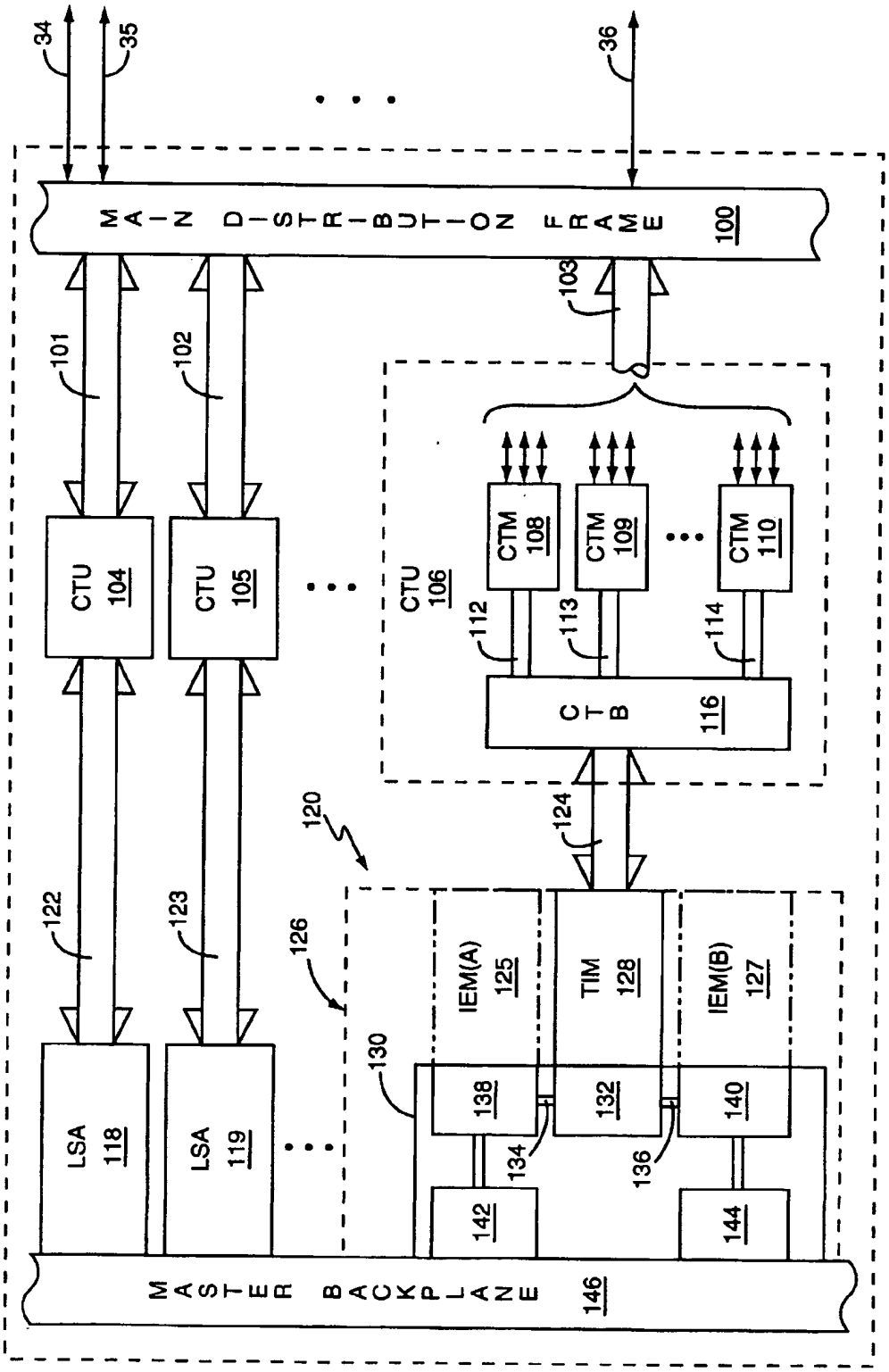

34
35
36
MAIN DISTRIBUTION FRAME 100
101
102
103
CTU 104
CTU 105
CTU 106
CTM 108
CTM 109
CTM 110
112
113
114
CTB 116
120
122
123
124
126
LSA 118
LSA 119
IEM(A) 125
TIM 128
IEM(B) 127
130
138
132
140
134
136
142
144
MASTER BACKPLANE 146

FIG. 4

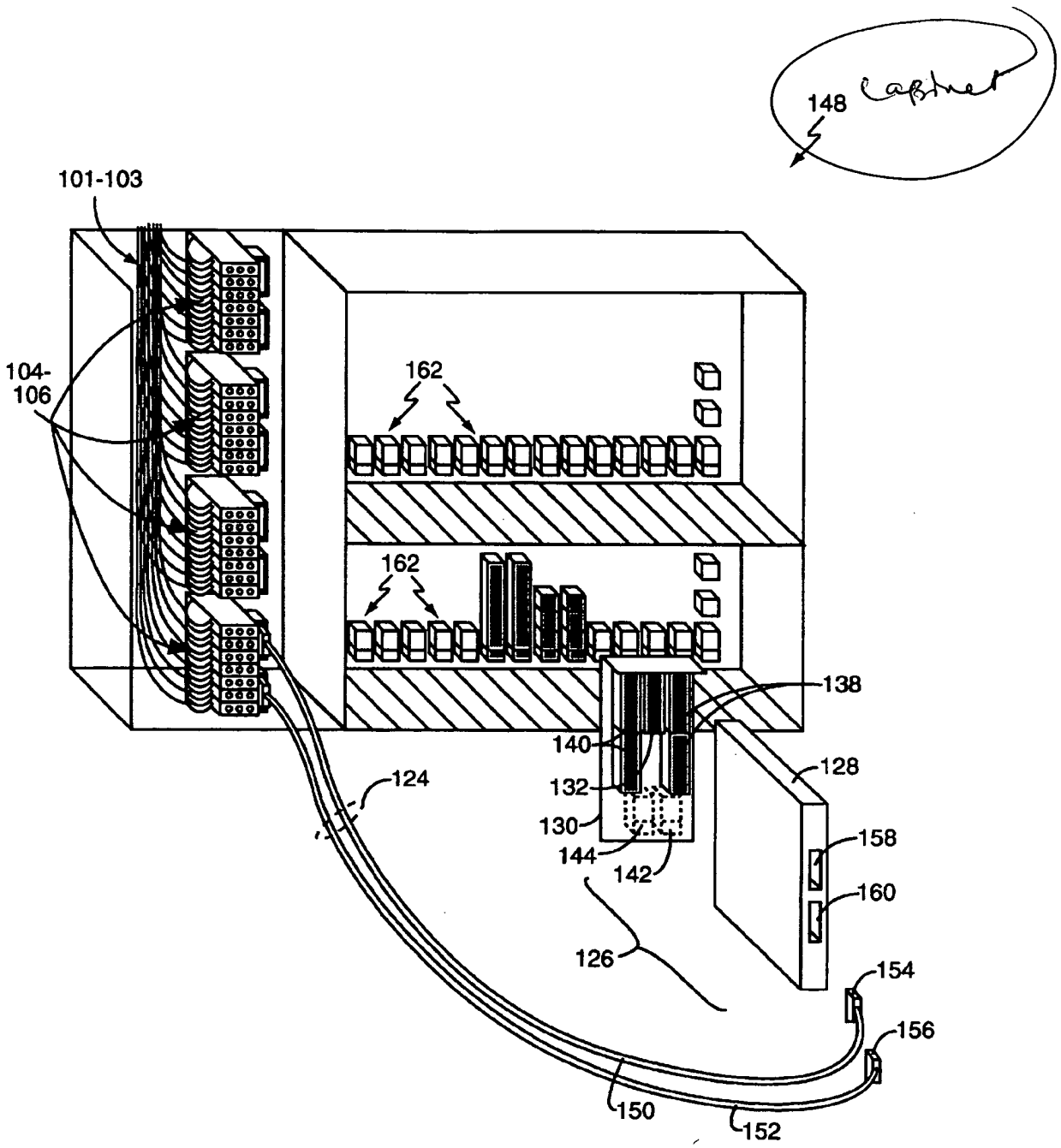

148
cabinet
101-103
104-
106
162
162
138
140
132
130
144
142
124
128
158
160
126
154
156
150
152

FIG. 5

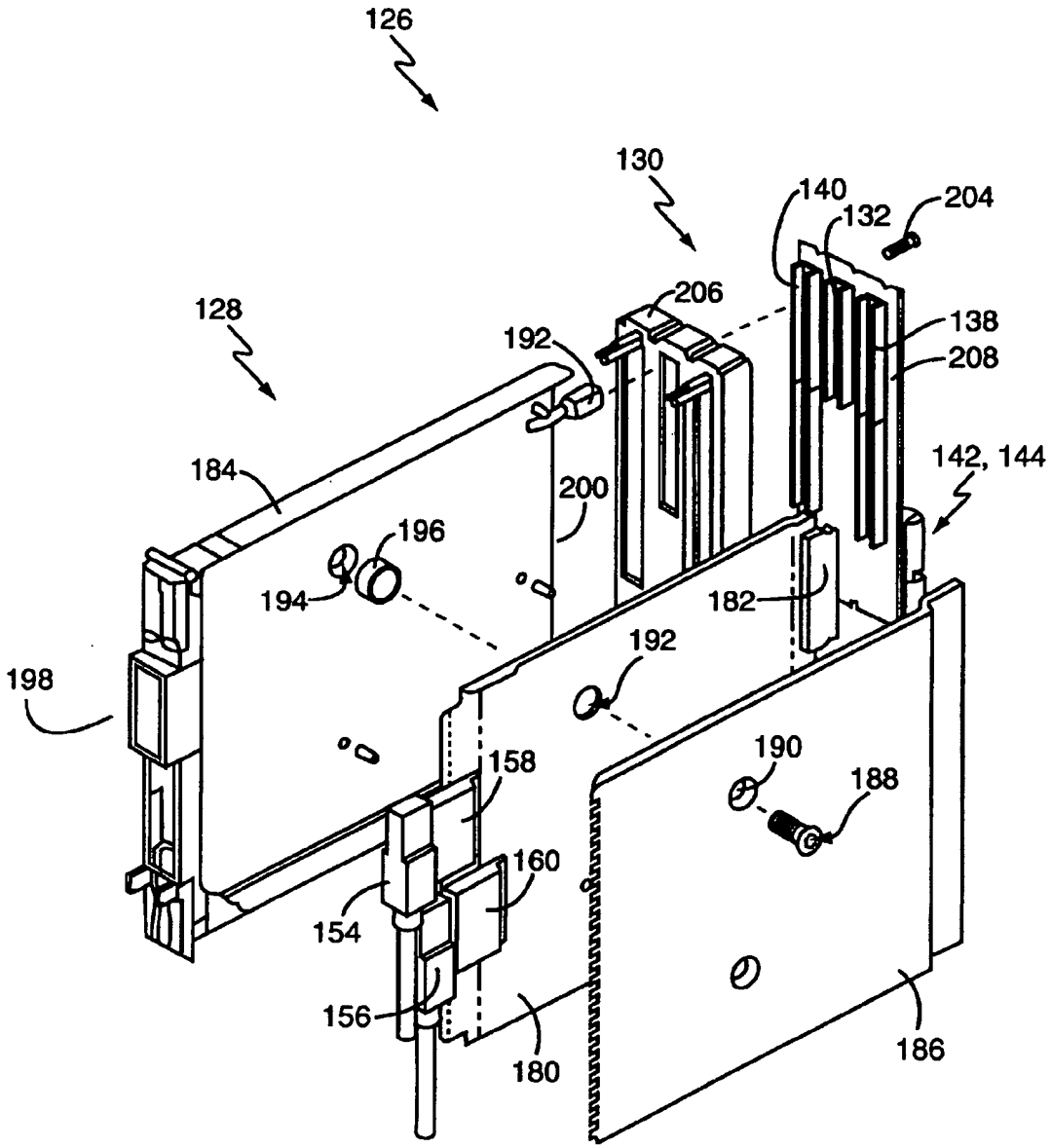

126
130
140
132
204
206
128
192
138
208
142, 144
184
200
196
194
182
192
198
158
190
188
160
154
156
180
186

FIG. 6

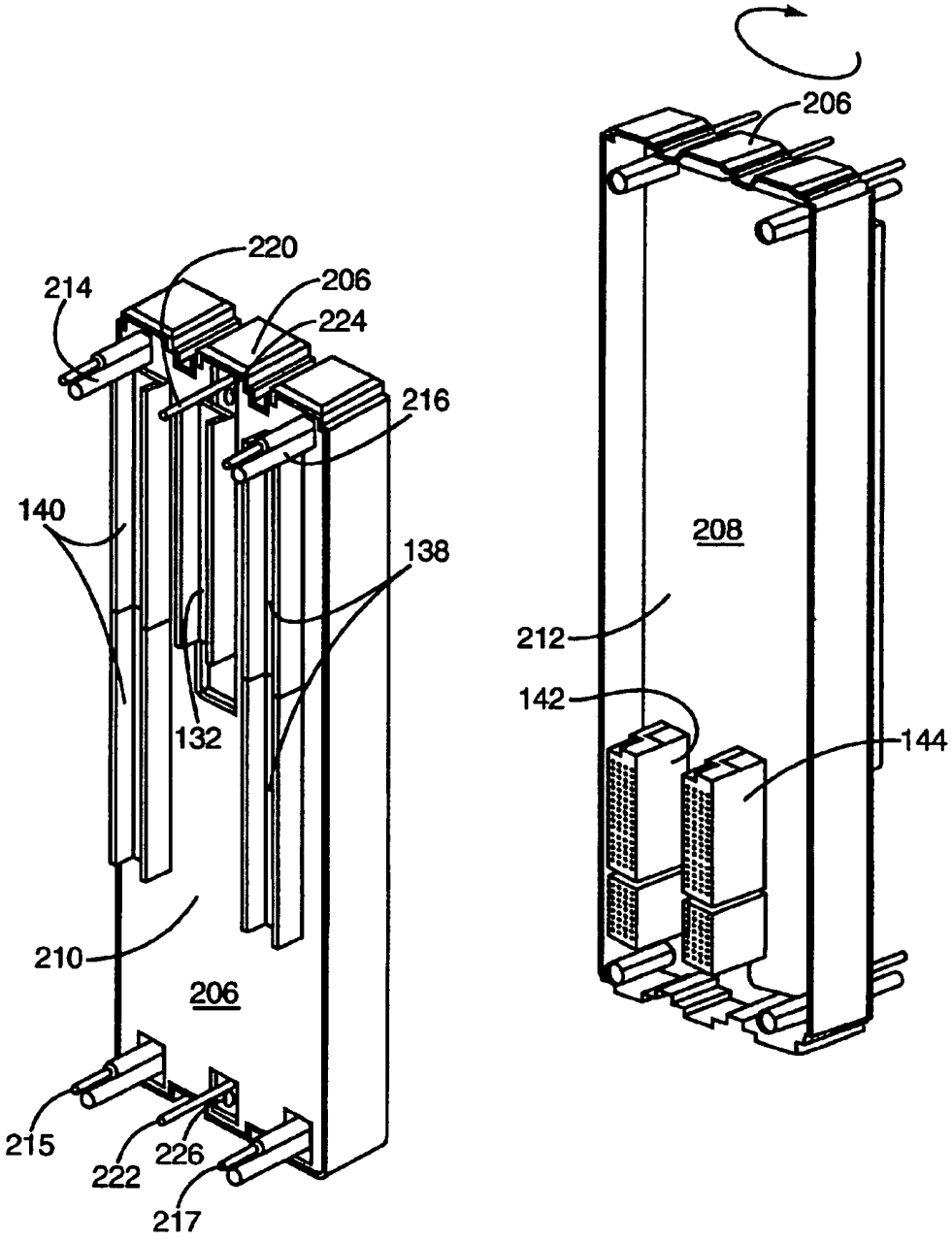

220
214
206
224
216
140
138
132
210
206
215
222
226
217
206
208
212
142
144

FIG. 7

MINI-BACKPLANE "T" ASSEMBLY

CROSS REFERENCE TO RELATED APPLICATIONS

Some of the material disclosed and claimed in this application is also disclosed in a commonly owned, copending U.S. patent application Ser. No. (Docket No. SN 0245) entitled: Way Finding with an Interactive Faceplate, filed on even date herewith by Janice M. Parker, et al

FIELD OF INVENTION

This invention relates to modular signal network equipment, and more particularly to apparatus for installing retrofit equipment modules into modular equipment mounting cabinets.

BACKGROUND OF THE INVENTION

With the rapid growth in communications technologies and the increased demand of network users for improved signal speed and reliability, network operators are faced with a constant need to upgrade network performance. The upgrades may be the result of improved technology or the availability of expanded system features. Other than in the case of generation changes where an entire system is replaced, these system upgrades are provided incrementally; generally through the retrofit of certain elements of the network circuitry with improved designs of those elements. With modular equipment, where function is often segregated into individual modules, the new design features can be installed in new version modules which are form and fit compatible with those of the existing installation.

There are, however, certain improvements which necessarily compromise form and fit compatibility, such as where a new design expands a particular function, requiring expanded signal connectivity to a module. This expanded connectivity can arise from a need for a greater number of input data sources or for added output load requirements. In these instantances the existing plant wiring is the bottleneck and some manner of plant wiring modification is required. This of course increases the cost of retrofit and may jeopardize the form and fit of the existing installed equipment. With changes in signal protocols and improvements in communications technologies, the frequency of occurrence of this type event is increasing. It is desirable, therefore, to provide a means to retrofit these type improvements into existing systems without the need for plant modifications.

DISCLOSURE OF THE INVENTION

The present invention is to apparatus capable of mounting retrofit modules to the mounting cabinetry of an installed modular equipment network. According to one feature of the invention the apparatus includes a combination mini-backplane and interface module which together provide surrogate mounting of the retrofit module with expanded connectivity external of the cabinet but with full functional connection with other equipment modules of the network. In further accord with this feature of the invention the present invention is configurable in either or both of the interface module and the mini-backplane to be adaptable for use in different network applications.

According to another feature of the invention, the apparatus is capable of mounting redundant, first and second retrofit modules in a manner which provides duplicate expanded connectivity and duplicate full functional connection to the network for each retrofit module, thereby providing for the addition of a high reliability retrofit function. In further accord with this feature of the invention the present mounting apparatus itself provides for full interconnectivity between the primary and secondary retrofit modules and for connection of each module with the network.

The mini-backplane T assembly of the present invention provides for the mounting of retrofit equipment modules into the existing equipment mounting cabinetry of an installed modular equipment signal network with minimum cost and disruption of the network operational The assembly includes an interface module and mini-backplane combination which is adapted for insertion into the equipment cabinetry with electrical signal connection of the mini-backplane to the cabinetry master backplane, and for mounting retrofit modules inserted therein in electrical signal interconnectivity with others of the network equipment modules. The interface module is capable of receiving expanded network signal lines external of the mounting cabinet backplane thereby providing for expanded connectivity of the retrofit modules with no modification of the cabinet itself.

These and other aspects and features of the present invention will become apparent to those ordinarily skilled in the art upon review of the following description of specific embodiments of the invention in conjunction with the accompanying Figures.

BRIEF DESCRIPTION OF DRAWING

FIG. **1**, is a perspective illustration of a best mode embodiment of a mini-backplane T assembly according to the present invention;

FIG. **2**, is a schematic block diagram of a wireless telephone network embodiment in which the present invention may be used;

FIG. **3**, is a schematic block diagram of one portion of the embodiment of FIG. **2**;

FIG. **4**, is a detailed schematic diagram of one element of the portion illustrated in FIG. **3**;

FIG. **5**, is a partially exploded, perspective illustration of equipment mounting cabinetry in which the assembly of FIG. **1** may be used;

FIG. **6** is an exploded perspective view of the assembly of FIG. **1**; and

FIG. **7** is a perspective illustration of one element of the assembly of FIG. **6**.

BEST MODE FOR CARRYING OUT THE INVENTION

In the following description of a best mode embodiment, the present invention is described in connection with the retrofit of an installed GSM protocol wireless telephone system for the purpose of expanding the function and connectivity of one element of the system. It should be understood, however, that the invention is not limited to wireless telephone systems or even to telephone systems in general, but may be used in connection with a number of different type signal network applications, and may also have utility in other generalized applications.

Referring first to FIG. **2**, which is a system block diagram of a known type wireless communication system **20**, such as the Nortel Networks Model PCS Digital Cellular System, in which mobile handset users **22, 24** communicate through antennae **26, 28** with base transceiver stations (BTS) **30, 32**. The BTS **30, 32** are connected through network lines **34–36** to a base station controller (BSC) **38**. The lines may be dual twisted pair copper wire, or coaxial cable both which

provide a differential signal transmission format. The BSC **38** manages the radio resources of the BTS **30, 32,** including hand-offs, traffic concentration and radio channel allocation, and communicates through lines **40** with the network's operation subsystem **42**. The subsystem **42** includes the Operations and Maintenance Center-Radio (OMC-R) **44**, which is a graphical interface that provides operation and maintenance functions, including performance management of the BSC.

The format of the digital signal transmission from the BTS **30, 32** may be in a DS-1 (or T1) protocol or, alternately, a PCM **30** (or E1) protocol. The BSC **38** provides the BTS signals on lines **46–48** to a transcoding unit (TCU) **50** at wireless system transmission speeds of 8 Kbps or 16 Kbps. The TCU **50** translates the wireless system signal speed into 64 Kbps m-law speech, thereby providing a minimum 4-to-1 expansion of traffic capacity.

The BTS **30, 32,** BSC **38,** operation subsystem **42** and TCU **50** collectively comprise the Base Station Subsystem (BSS), which is the interface between the mobile handset users and the Network Switching Subsystem (NSS) **55**. The NSS **55** provides the switching, mobility, and subscriber management required for operation of the wireless system. It includes the network DMS (Digital Multiplex Switch) Mobility Switching Center (DMS-MSC) **56** which is connected through lines **57** to the Operation Subsystem **42** and through lines **58** to the public switch telephone network (PSTN) **60** to coordinate the call setup between the PSTN and the BSS. The DMS-MSC **56** also includes a visitor location register (VLR) **61** which stores subscriber information.

The NSS **55** also includes an intelligent network (IN) **62**, which provides databases and computer signal processing for subscriber and equipment validation, subscriber tracking, and service delivery. Components of the IN **62** include: a home location register (HLR) **64**, an authentication center **66**, a short message service (SMS) center **68**, and an equipment identity register **70**. All of which are connected to the DMS-MSC **56**.

As described in the hereinbefore cross referenced, copending application to Parker et al, which is hereby incorporated by reference herein, a modification was made to system **20** to expand the capability of the system operator to quickly access and isolate signal line faults. A number of electronics modules (IEMs) was added by retrofit to expand the system's diagnostic function; i.e. to perform real time monitoring of signal quality on each of the network signal lines and to display performance monitored results on an equipment faceplate. Each of the network signal lines entering the BSC and TCU equipment site were routed through one of a plurality of added IEM modules. This change also expanded diagnostic features by providing an interactive faceplate at each IEM. The faceplate included a number of operator visible displays for visual reporting of signal faults and alarm conditions detected by the IEM. In addition, due to the increased circuit complexity and circuit component density of the IEM, it was considered necessary to use dual redundant IEMs to ensure system reliability, thereby further increasing the required connectivity beyond that available in the master backplane of the equipment mounting cabinetry. The mini-backplane T assembly of the present invention provided the means of adding the IEMs.

The IEMs where added as Low Speed Access (LSA) equipment at the interface of the BSC **38** and TCU **50** equipment with the network lines. This, together with the availability of loop back testing of each line, allowed the system operator to isolate signal faults to either the network equipment (at the BSC or TCU) or to the network lines. FIG. **3** is a system block diagram of the BSC **38**, which receives the network lines **34–36** at the interface **72**. The signal lines are pass from the interface **72** through lines **74** to the BSC Common Equipment Module (CEM) **76**, which provides the central processing for the BSC as well as: time switching of the pulse code modulated (PCM) data, routing of the signal line data between the interface unit **72** and the remote module (RM) time switch **78**, and communicating through the ATM resource module (RM) interface **80** with the ATM backplane (not shown) of the BSC Control Node **81**. The CEM passes the voice and data channel signals through lines **82** and through a second interface **84** onto lines **46–48** to the TCU **50** (FIG. **2**).

The interface **72** is illustrative of each of the interfaces added to the BSC **38** and TCU **50**. Referring to FIG. **4**, the interface **72** receives the network signal lines **34–36** from the BTS **30, 32** (FIG. **2**) at a Main Distribution Frame (MDF) **100**, which functions as a transition point between the outside lines and the BSC hardware. The DS-1 or PCM **30** network lines are routed in sub-groups of lines **101–103** to associated ones of a plurality of Cable Transition Units (CTUs) **104–106**. Each CTU, as shown by CTU **106**, includes a plurality of Cable Transition Modules (CTMs) **108–110**. The CTMs provide secondary surge protection (primary surge protection, including lightening protection being provided at the MDF **100**), passive impedance matching electronics in the case of PCM **30** coax or DS-1 twisted pair, and manual loopback switches for each connected network line. As known, the loopback switches permit isolation of trunk line signal faults to the BSC equipment itself or to the network lines **34–36**.

The number of network lines connected through each CTU **104–106** is a function of the system signal bandwidth and the network signal protocol. Each CTU is capable of receiving either **28** DS-1 type signals or **21** PCM **30** type signals. Assuming a PCM **30** protocol the CTU receives **21** lines, which are divided between the CTMs. Each CTM is a multilayer circuit board capable of supporting up to three PCM **30** lines, either twisted pair, or coaxial, for a maximum of seven CTMs per CTU. The network signals from the CTMs **108–110** are coupled through lines **112–114** to a Cable Transition Board (CTB) **116** and onto lines **124** to Low Speed Access (LSA) modules **118, 119, 120.**

As described above the LSAs represent the retrofitted function for system **20** and, as shown by LSA **120**, each includes dual redundant IEM modules **125, 127** (shown in phantom) mounted into the mini-backplane T assembly **126** of the present invention. The mini-backplane assembly **126** is shown schematically, to include a Transition Interface Module (TIM) **128** which is removably, but fixedly attached to a mini-backplane **130**. In the illustrated embodiment the TIM **128** provides passive EMI filtering of each network line and presents the lines to a signal connector **132** of the backplane **130**. The backplane routes the network signal lines to each IEM through duplicate network signal line wiring **134, 136** to signal connectors **138, 140**, each of which are adapted to receive an associated one of the IEMs **125, 127**. Each IEM provides its signal output, which includes the network signal lines to signal connectors **142, 144** which are adapted to functionally engage associated signal connectors of a master backplane **146** of the equipment mounting cabinet **148** of FIG. **5**.

Referring to FIG. **5**, which is a figurative perspective illustration, not to scale, of equipment mounting cabinetry of the type used for the modular equipment of the wireless

network **20**. The illustration is only intended to show the relational fit of the mini-backplane assembly to the system equipment cabinet. Using the same reference numerals for the same elements shown in FIG. **4**, the mini-backplane T assembly **126** is shown in an exploded view which separates the TM **128** from the mini-backplane **130**. The TIM receives the network signal lines **124** embodied in separate transmit and receive cables **150, 152** which are connected through cable connectors **154, 156** and **158, 160** to the TIM.

The TIM housing fixedly attaches to the mini-backplane housing **206** on FIG. **6** causing the TIM signal connector **182** (FIG. **6**) to engage the mini-backplane connector **132**. With installation of the mini-backplane assembly **126** into the cabinet **148**, the backplane signal connectors **142, 144** (shown in phantom as on the reverse side of the mini-backplane **130**) engage the associated ones of the signal connectors **162** of the master backplane **146** of the cabinet **148**. With the assembly installed in the cabinet, the IEMs (**125, 127**, FIG. **4**) are inserted into the assembly **126** and the IEM signal connectors engage the mini-backplane signal connectors **138, 140**.

Referring now to FIG. **1**, which is a perspective illustration of the present mini-backplane T assembly. As in FIG. **5**, the same reference numbers are used to identify the same elements. The mini-backplane assembly **126** includes the TIM **128**, which is mounted to the mini-backplane housing **130** and which receives the network signal line connectors **154, 156** at the TIM signal input connectors **158, 160**. As described hereinbefore, the assembly **126** is adapted to be slidably inserted into the cabinet until the mini-backplane signal connectors **142, 144** (FIG. **5**) engage the associated signal connectors **162** of the cabinet master backplane **146** (FIG. **5**). With the assembly fully inserted, lock latches (or "thumb latches") **166, 168** which are hinge mounted on the TIM front panel **169**, also referred to as the TIM near side end wall, are rotated in the manner shown by the latch adjacent rotational arrows, to engage a channel **170, 172** formed in each of the locklatchs with shelf rails **174, 176** formed on the top and bottom of the cabinet **148**. When fully depressed the locklatches **168, 170** are held in tension, snugged against the near side end wall **169**, thereby securing the assembly **126** in its cabinet mounting.

FIG. **6** is an exploded perspective view of the mini-backplane assembly **126** showing the major elements of the TIM **128** and mini-backplane **130**. The TIM includes a circuit board assembly **180** with mounted cable signal connectors **158, 160**, and the TIM signal connector **182**, which connects to the mini-backplane connector **132**. In a best mode embodiment the circuit board **180** is enclosed in a sheet metal housing, comprising a base **184** and a top **186**. The top **186** is fastened to the base **184** with fasteners **188**, preferably hex screws **188**, which are connected through apertures **190** in the top, **192** in the board **180** and **194** in the base **184**. To maintain spacing within the housing, spacers **196** are used to maintain the space to-part-distance of the top to the base.

The base **184** includes the TIM near side end wall **198** and far side end wall **200**. The far side end wall includes a fastener assembly **202**, a threaded housing which is fastened to the TIM base **184** and which is adapted to engage a hex screw **204** which passes through the mini-backplane f**0** and engages the TIM to a housing **206** of the assembly. The housing **206** is adapted to receive the mini-backplane assembly connectors **132, 138, 140**, and the mini-backplane **208**. Although the TIM housing base **184** and top **186** are shown in a best mode embodiment to comprise sheet metal, it should be understood that various other type sheet materials may be used as deemed suitable for use in a given application by those skilled in the art.

In FIG. **6** the mini-backplane connectors **142, 144** are electrically connected to the connectors **132, 138** and **140** through the backplane **208**. The backplane is a multilayer printed circuit board in which the conductive signal paths are arranged as copper traces (not shown) on several different ones of the multilayers. The actual arrangement and layout of the traces is dependent on the particular application. In the system **20** application layout considerations included ensuring that no vias were used with the network signal lines so as to ensure signal integrity. In addition the copper trace widths were selected to maintain a nominal network signal impedance. With the wireless telephone system application the network signal traces were adjusted to maintain a nominal **120** ohm differential impedance between the trunk line tip and ring.

FIG. **7** is a perspective illustration of the mini-backplane itself showing the TIM mating side **210** and the master backplane (or cabinet mounting side) **212**. The TIM mounting side includes the signal connectors **132, 138, and 140** which are male connectors. The cabinet mounting side **212** includes connectors **142, 144** which are female connectors. The mini-backplane frame **206** includes guide pins **214, 215, 216, 217** which are adapted for insert into guide channels in each of the IEM modules. Similarly, the TIM interface includes guides **220, 222** which perform the similar function with the TIM. Adjacent each of the TIM guide pins **220, 222** are the apertures or screw holes **224, 226** through which the hex screws (**204**, FIG. **6**) pass to engage the threaded housing (**202**, FIG. **6**) of the TIM.

The mini-backplane assembly of the present invention provides for the retrofit of new design modules to existing equipment with minimum cost. It allows for the installation of expanded connectivity retrofit modules without mechanical modification or wiring changes to the installed mounting cabinetry. The TIM is also configuration adaptable in that various functions, both active and passive, may be added to the circuit board to support the retrofit, as may be necessary or deemed desirable. All of which adds to its versatility in facilitating retrofit modification of installed systems.

The mechanical configuration of the present mini-backplane also simplifies its installation into the system by providing a front located mechanical latch which secures the assembly into the cabinet. There is no requirement for rear access to the cabinet for installation or removal. Everything may be done from the front access of the cabinet thereby facilitating the quick replacement of the retrofit modules installed in the assembly, as may be necessary in the event of a functional failure, so as to minimize the disruption to network traffic. In addition, and a distinctive feature of the mini-backplane is the ease with which it may be inserted and removed; without the need for tools of any type.

Similarly, although the invention has been shown and described with respect to a best mode embodiment thereof, it should be understood by those skilled in the art that various changes, omissions, and additions may be made to the form and detail of the disclosed embodiment without departing from the spirit and scope of the invention, as recited in the following claims.

We claim:

1. Apparatus, for molting retrofit equipment modules in a mounting cabinet of a modular equipment network, the mounting cabinet being of the type in which connectors of equipment modules are inserted in the mounting cabinet in side by side orientation to engage master backplane signal

connectors coupled to a master backplane within the cabinet, said apparatus comprising:

a mini-backplane, having first and second major surfaces opposing one another and extending along a common periphery, said first major surface having one or more first signal connectors adapted to releasably engage a signal connector of a retrofit module, said second major surface having one or more second signal connectors adapted to releasably engage one or more of said master backplane signal connectors, said first major surface further having a third signal connector being electrically connected to said first signal connectors, said second signal connectors being electrically connected to corresponding ones of said first signal connectors;

an interface module, having an interface module connector and a housing, said interface module connector adapted to engage said third signal connector, said housing including a near side end wall spaced longitudinally from a far side end wall and at least one side wall extending between the far side end wall and the near side end wall; and

a peripheral frame, adapted to fixedly engage said common periphery of said mini-backplane and said far side end wall of said interface module in a mainer to fixedly position said at least one side wall of said interface module in a substantially orthogonal orientation to said first and second major surfaces of said mini-backplane, to provide a mounting apparatus which is adapted to engage said master backplane connectors of said master backplane with said second signal connectors and to receive a retrofit module adjacent to said interface module by engaging said signal connector of the retrofit module with one of said first signal connectors, thereby interconnecting the retrofit module with other cabinet mounted modules.

2. The apparatus of claim 1, wherein:

said interface module further comprises an interface circuit board adapted for mounting within said housing, said housing further including a network signal connector disposed on said interface module, said network signal connector being adapted to receive network signal lines external of the master backplane and for providing said network signal lines through said printed circuit board to said interface module connector; and

one or more of said first signal connectors of said mini-backplane are adapted to releasably engage said interface module connector, said mini-backplane being further adapted to distribute some and, alternately, to distribute all of the network signals between said first signal connectors, from said interface module connector to said signal connector of the retrofit module, thereby providing the retrofit module with a greater signal connectivity than is available through connection to the master backplane.

3. The apparatus of claim 2, wherein:

said mini-backplane comprises a printed circuit board having one or more layers therein, each of said one or more layers including one or more signal conductors for electrically interconnecting said first signal connectors to said third signal connector in a manner to provide signal interconnection of said interface module connector with said signal connector of said retrofit module, and for electrically connecting some or all of said first signal connectors with said second signal connectors.

4. The apparatus of claim 2, wherein:

said printed circuit board is adapted to perform signal conditioning of the network signals conducted therethrough.

5. The apparatus of claim 4, wherein said signal conditioning comprises limiting the signal amplitude of the network signals to a selected magnitude.

6. The apparatus of claim 1, wherein:

said interface module further includes latching means disposed thereon, said latching means being adapted for releasable engagement to a portion of the mounting cabinet to provide, when engaged, the securing of said mounting apparatus within the cabinet.

7. The apparatus of claim 6, wherein:

said latching means includes one or more thumb latches which are pivotally mounted on said housing of said interface module and which include a latching end adapted to contact, with said apparatus inserted in the mounting cabinet, a portion of the mounting cabinet, said latching end thereafter maintaining said contact under force with closure of said one or more thumb latches by the operator and releasing said contact with the opening of said one or more thumb latches by the operator.

8. The apparatus of claim 1, wherein said housing comprises a sheet metal material.

9. Apparatus, for mounting first and second retrofit equipment modules in a mounting cabinet of a modular equipment network, the mounting cabinet being of the type in which equipment modules are inserted in the mounting cabinet in side by side orientation to engage master backplane signal connectors to a master backplane within the cabinet, said apparatus comprising:

a mini-backplane, having first and second major surfaces opposing one another and extending along a common periphery, said first major surface having at least two first signal connectors, each adapted to releasably engage a signal connector of first and second retrofit modules, said second major surface having one or more second signal connectors adapted to releasably engage one or more of said master backplane signal connectors, said first major surface further having a third signal connector being electrically connected to said first signal connectors, said second signal connectors being electrically connected to corresponding ones of said first signal connectors;

an interface module, having an interface module connector and a housing, said interface module connector adapted to engage said third signal connector, said housing including a first end wall spaced longitudinally from a second end wall, said housing further including side walls spaced transversely between said end walls; and

a peripheral frame, adapted to fixedly engage said common periphery of said mini-backplane and said second end wall in a manner to fixedly position said side walls of said interface module in a substantially orthogonal orientation to said first and second major surfaces of said mini-backplane, to provide a mounting apparatus which is adapted to engage said master backplane connectors of said master backplane with said second signal connectors and to receive the first and second retrofit modules in side by side proximity with said interface module and with engagement of the signal connector of said first and second retrofit modules with a corresponding one of said first signal connectors,

thereby interconnecting the first and second retrofit modules with other cabinet mounted modules.

10. The apparatus of claim **9**, wherein:

said interface module further comprises a printed circuit board adapted for mounting within said housing, said housing further including a network signal connector disposed on the first end wall of said interface module near side end wall and a second interface module signal connector disposed on said far, said network signal connector being adapted to receive network signal lines external of the mounting cabinet and for providing said network signal lines through said circuit board to said interface module connector; and

said first signal connectors of said mini-backplane are further adapted to releasably engage said interface module connector, and said mini-backplane is further adapted to distribute one or more of said network signals between said first signal connectors to said signal connector of each of the first and second retrofit modules, thereby providing the first and second retrofit modules with greater signal connectivity than is available through connection to the master backplane.

11. The apparatus of claim **10**, wherein:

said printed circuit board is adapted to perform signal conditioning of the network signals conducted therethrough.

12. The apparatus of claim **11**, wherein said signal conditioning comprises limiting the signal amplitude of the network signals to a selected magnitude.

13. The apparatus of claim **10**, wherein:

said mini-backplane comprises a printed circuit board having one or more layers therein, each said of said one or more layers including one or more signal conductors for electrically interconnecting said first signal connectors to said third signal connector in a manner to provide signal interconnection of said interface module connector with each said signal connector of the first and second retrofit modules, and for electrically connecting some or all of said first signal connectors with said second signal connectors.

14. The apparatus of claim **9**, wherein:

said first end wall of said interface module further includes latching means disposed thereon, said latching means being adapted for releasable engagement to a portion of the mounting cabinet to provide, when engaged, the securing of said mounting apparatus within the cabinet.

15. Apparatus of claim **14**, wherein:

said latching means includes one or more thumb latches which are pivotally mounted on said first end wall and which include a latching end adapted to contact, with said apparatus inserted in the mounting cabinet, a portion of the mounting cabinet, said latching end thereafter maintaining said contact under force with closure of said one or more thumb latches and releasing said contact with the opening of said one or more thumb latches.

16. The apparatus of claim **9**, wherein said housing comprises a sheet metal material.

17. Apparatus, for mounting retrofit equipment modules in a mounting cabinet of a modular equipment network, the mounting cabinet being of the type in which connectors of equipment modules are inserted in the mounting cabinet in side by side orientation to engage master backplane signal connectors coupled to a master backplane within the cabinet, said apparatus comprising:

a mini-backplane, having first and second major surfaces opposing one another and extending along a common periphery, said first major surface having one or more first signal connectors adapted to releasably engage a signal connector of a retrofit module, said second major surface having one or more second signal connectors adapted to releasably engage one or more of said master backplane signal connectors, said first major surface further having a third signal connector being electrically connected to said first signal connectors, said second signal connectors being electrically connected to corresponding ones of said first signal connectors;

an interface module, having a housing and an interface module connector adapted to engage said third signal connector; and

a frame, adapted to fixedly engage said mini-backplane and said interface module in a manner to fixedly position said interface module in a substantially orthogonal orientation to said first and second major surfaces of said mini-backplane, to provide a mounting apparatus which is adapted to engage said master backplane connectors of said master backplane with said second signal connectors and to receive a retrofit module adjacent said interface module by engaging the signal connector of the retrofit module with one of said first signal connectors, thereby interconnecting the retrofit module with other cabinet mounted modules.

* * * * *

US-PAT-NO: 6243273

DOCUMENT-IDENTIFIER: US 6243273 B1

TITLE: Mini-**backplane** "T" assembly

DATE-ISSUED: June 5, 2001

INVENTOR-INFORMATION:

NAME	CITY	STATE	ZIP CODE	COUNTRY
Beun; Roger Arthur	Kanata	N/A	N/A	CA
Craig, Jr.; William	Durham	NC	N/A	N/A
Locke	Nepean	N/A	N/A	CA
Lommen; Joseph John	Cary	NC	N/A	N/A
Broniak; Janice Parker	Cary	NC	N/A	N/A
Liou; Derek Chunchi	Apex	NC	N/A	N/A
Taylor; Jeffrey Scott				

US-CL-CURRENT: 361/796; **361/704** ; 361/741 ; 361/756 ; 361/788 ; 361/797 ; 439/260 ; 439/261 ; 439/325 ; 439/326 ; 439/327 ; 439/630 ; 439/631

ABSTRACT:

Apparatus for mounting retrofit equipment **modules** into the equipment mounting cabinetry of an installed modular equipment signal network includes an interface **module** and mini-**backplane** combination which is adapted for insertion into the equipment cabinetry with electrical signal connection of the mini-**backplane** to the cabinetry master **backplane**, and for mounting retrofit **modules** inserted therein in electrical signal interconnectivity with others of the network equipment **modules**.

17 Claims, 7 Drawing figures

Exemplary Claim Number: 1

Number of Drawing Sheets: 7

US006195493B1

(12) **United States Patent**
Bridges

(10) **Patent No.: US 6,195,493 B1**
(45) **Date of Patent: Feb. 27, 2001**

(54) **UNIVERSAL CHASSIS FOR CATV HEADENDS OR TELECOMMUNICATIONS COMPANY CENTRAL OFFICE FOR OPTICAL ELECTRONIC EQUIPMENT**

(75) Inventor: **Rodney Lee Bridges**, Lilburn, GA (US)

(73) Assignee: **Scientific-Atlanta, Inc.**, Lawrenceville, GA (US)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

(21) Appl. No.: **09/316,232**

(22) Filed: **May 21, 1999**

(51) **Int. Cl.**[7] **G02B 6/00**
(52) **U.S. Cl.** **385/134**
(58) **Field of Search** 385/134, 135, 385/147; 312/319.1, 333, 334.46; 370/217; 361/685, 727, 752, 788, 796

(56) **References Cited**

U.S. PATENT DOCUMENTS

4,699,270	*	10/1987	Bohm	312/107
5,173,845	*	12/1992	Shaw	361/798
5,398,161	*	3/1995	Roy	361/727
5,790,518	*	8/1998	Nguyen et al.	370/217
6,007,169	*	12/1999	Li et al.	312/223
6,053,808	*	4/2000	Koradia et al.	454/184

* cited by examiner

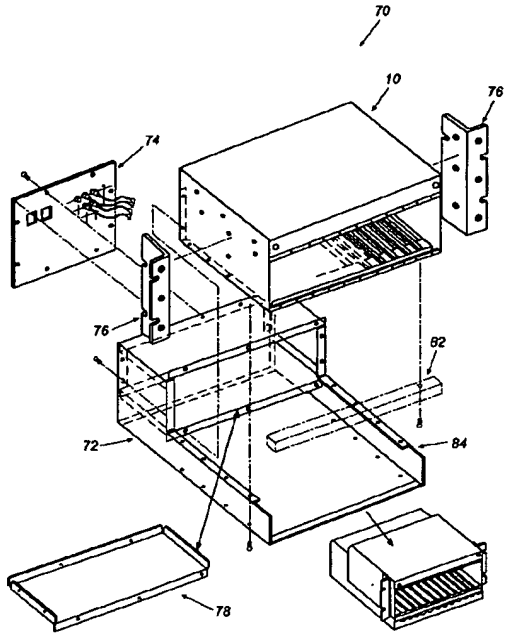
Primary Examiner—Akm E. Ullah

(74) *Attorney, Agent, or Firm*—Kelly A. Gardner; Kenneth M. Massaroni; Hubert J. Barnhardt

(57) **ABSTRACT**

A reconfigurable chassis provides thermal management of external electrical modules that are inserted into the chassis and removed from the chassis. The chassis includes a housing into which modules are inserted, and the housing has a front portion and a back portion and further has multiple guides for holding the modules. A removable fan tray is located on top of the housing. The removable fan tray holds fans in first and second positions, wherein, when the fans are located in the first position, air is directed from the front portion of the chassis, and wherein, when the fans are located in the second position, air is directed from the back portion of the chassis. The chassis also includes a removable rear connector panel for use when electrical cables coupled to the modules are to be accessed from the back portion of the housing. The removable rear connector panel is mounted to the back portion of the housing for electrically coupling to the electrical cables that are coupled to the modules. A removable panel bracket is used when the electrical cables coupled to the modules are to be accessed from the front portion of the housing. The removable panel bracket is mounted beneath the housing for routing the electrical cables from the back portion of the housing to the front portion of the housing. When the electrical cables coupled to the modules are to be accessed front the front portion of the housing, a removable front connector panel is also used, and the removable front connector panel is mounted to the front portion of the housing for electrically coupling to the electrical cables that have been routed through the removable panel bracket.

11 Claims, 18 Drawing Sheets



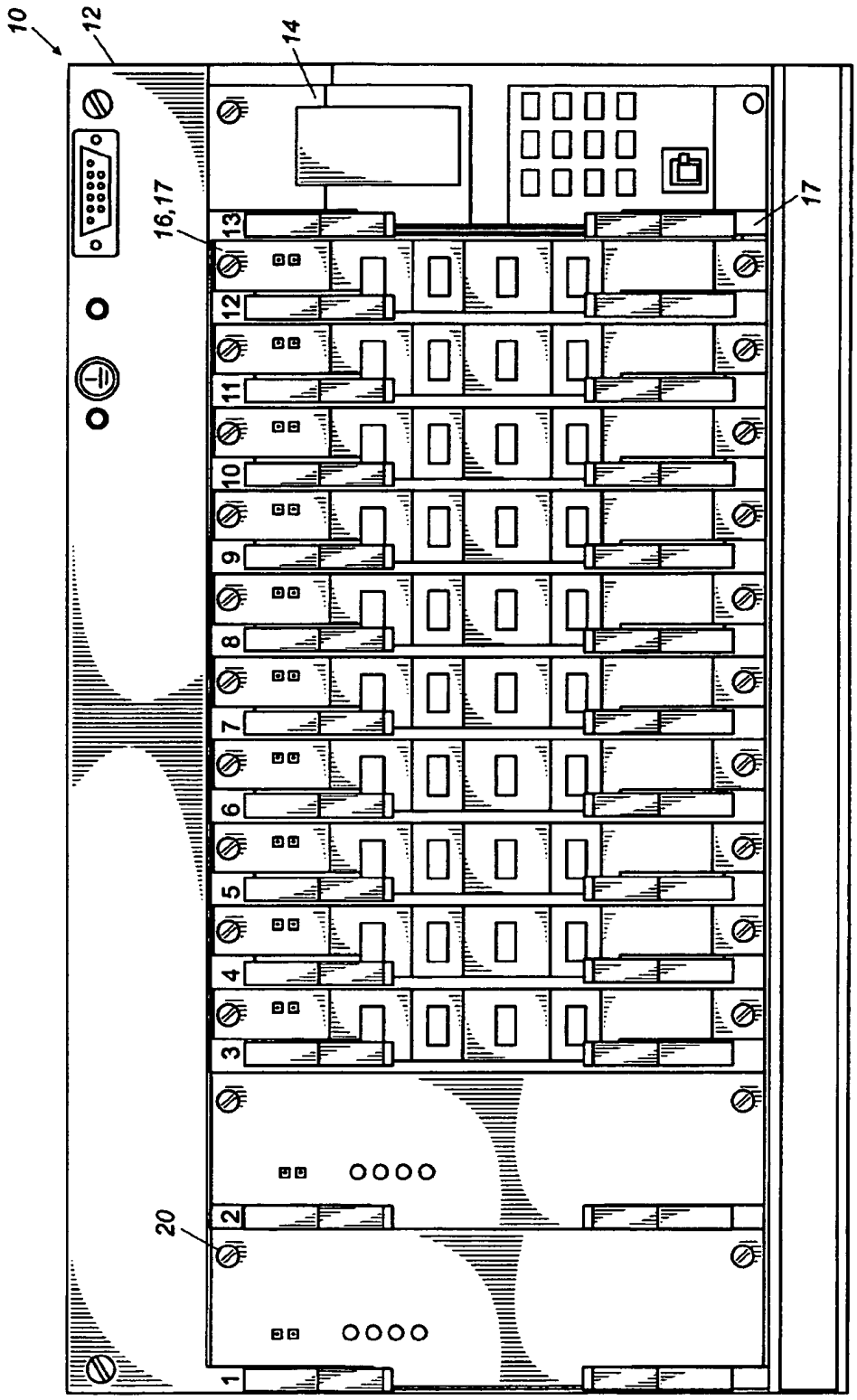


Fig. 1

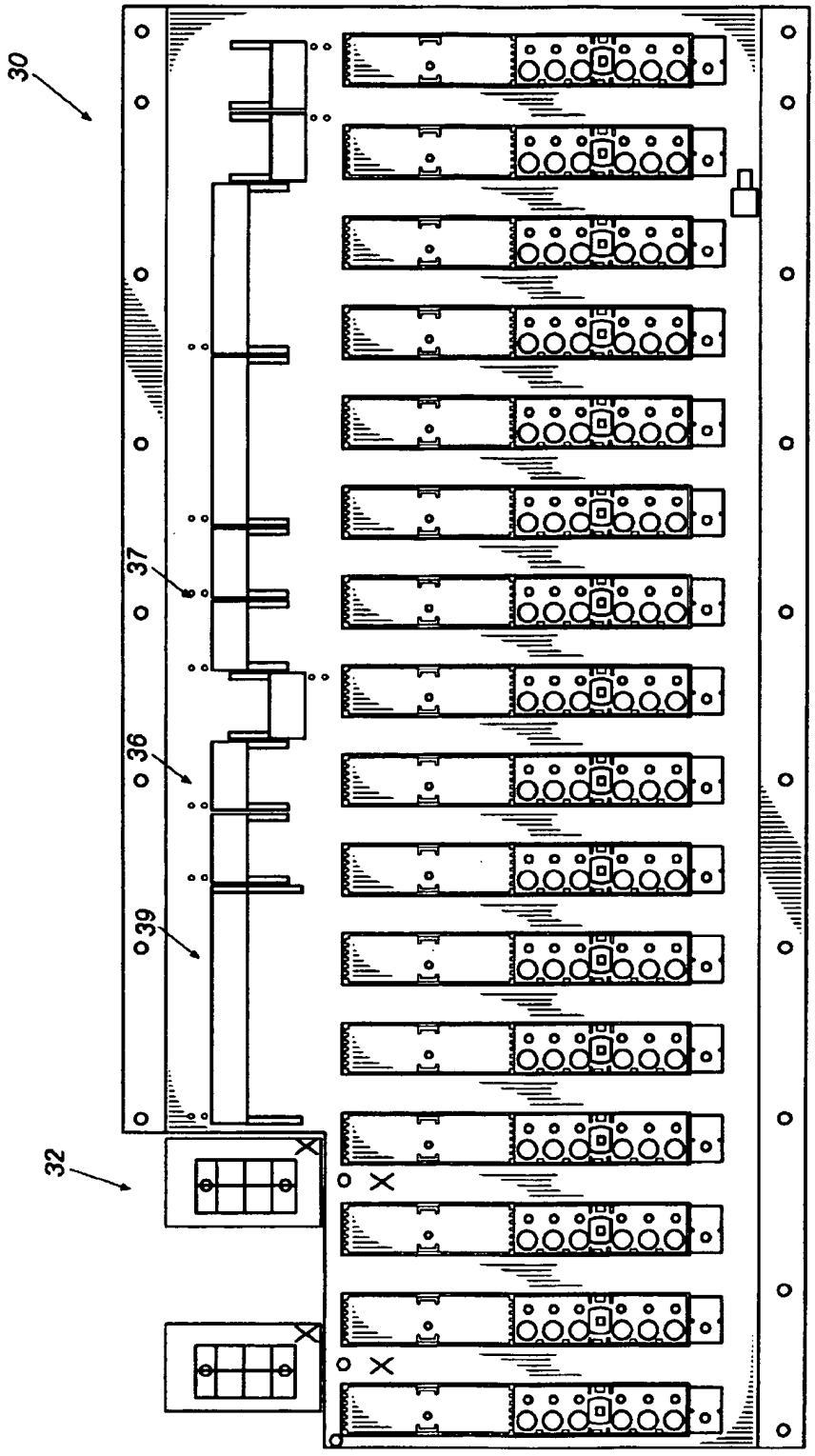


Fig. 2

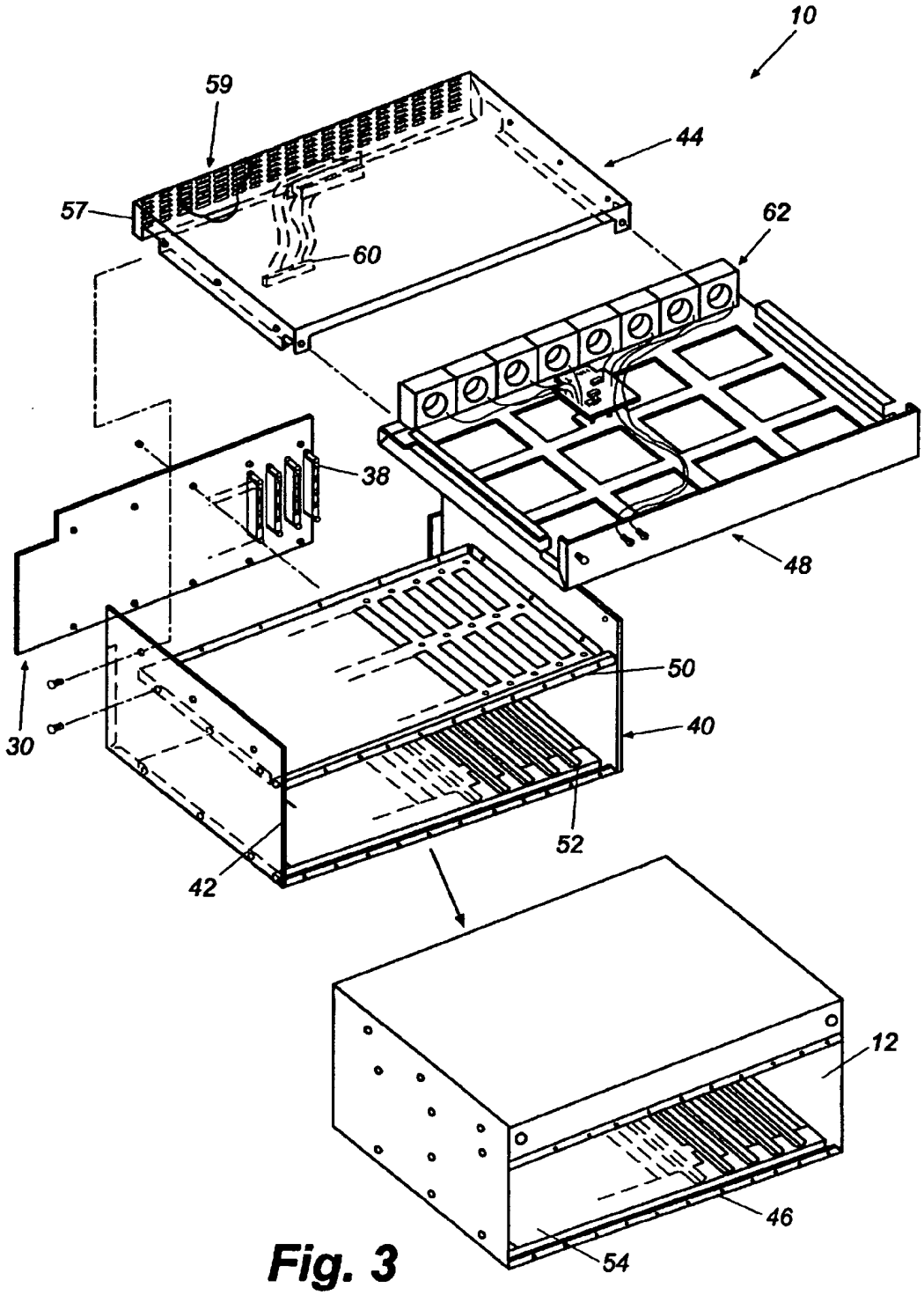


Fig. 3

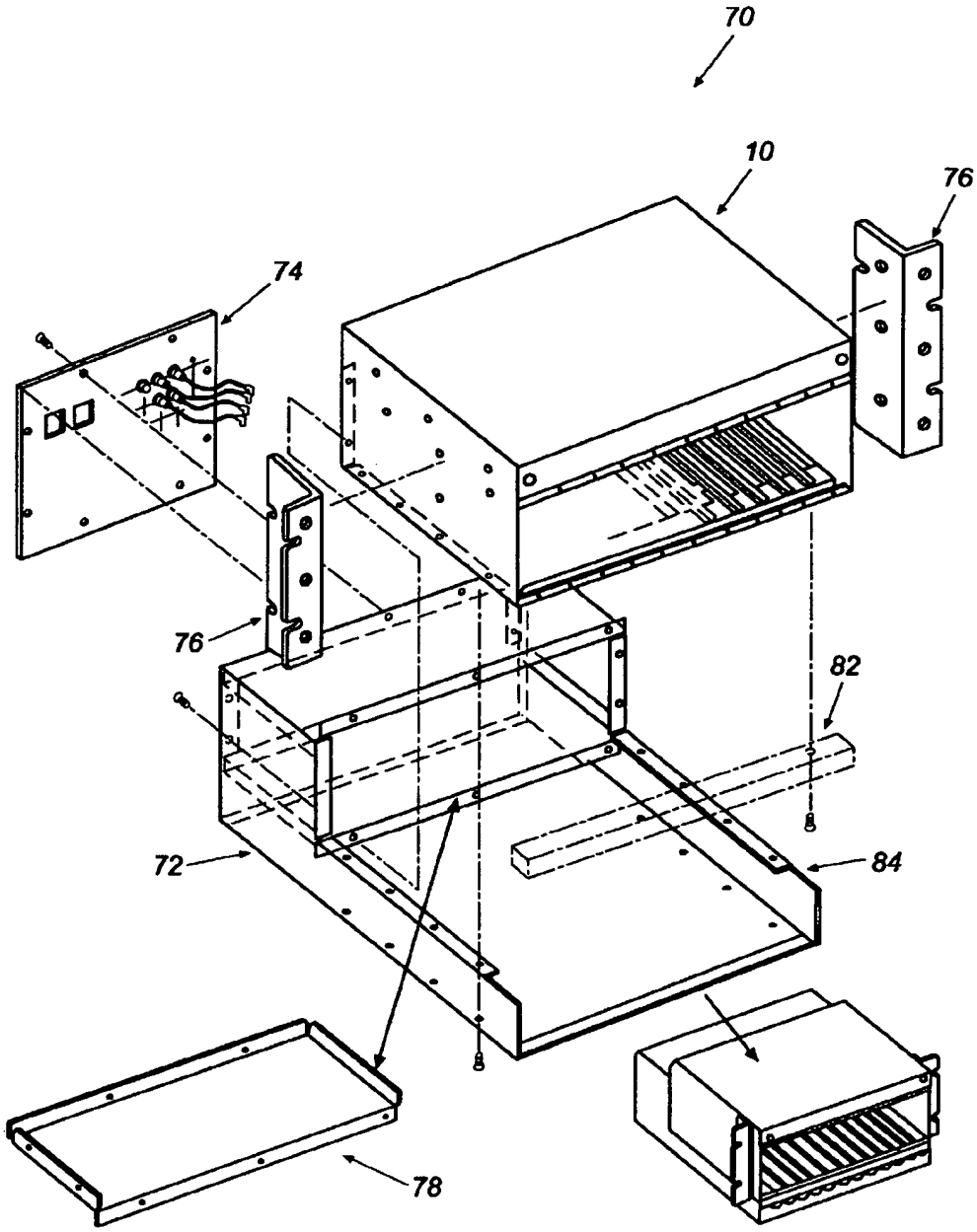


Fig. 4

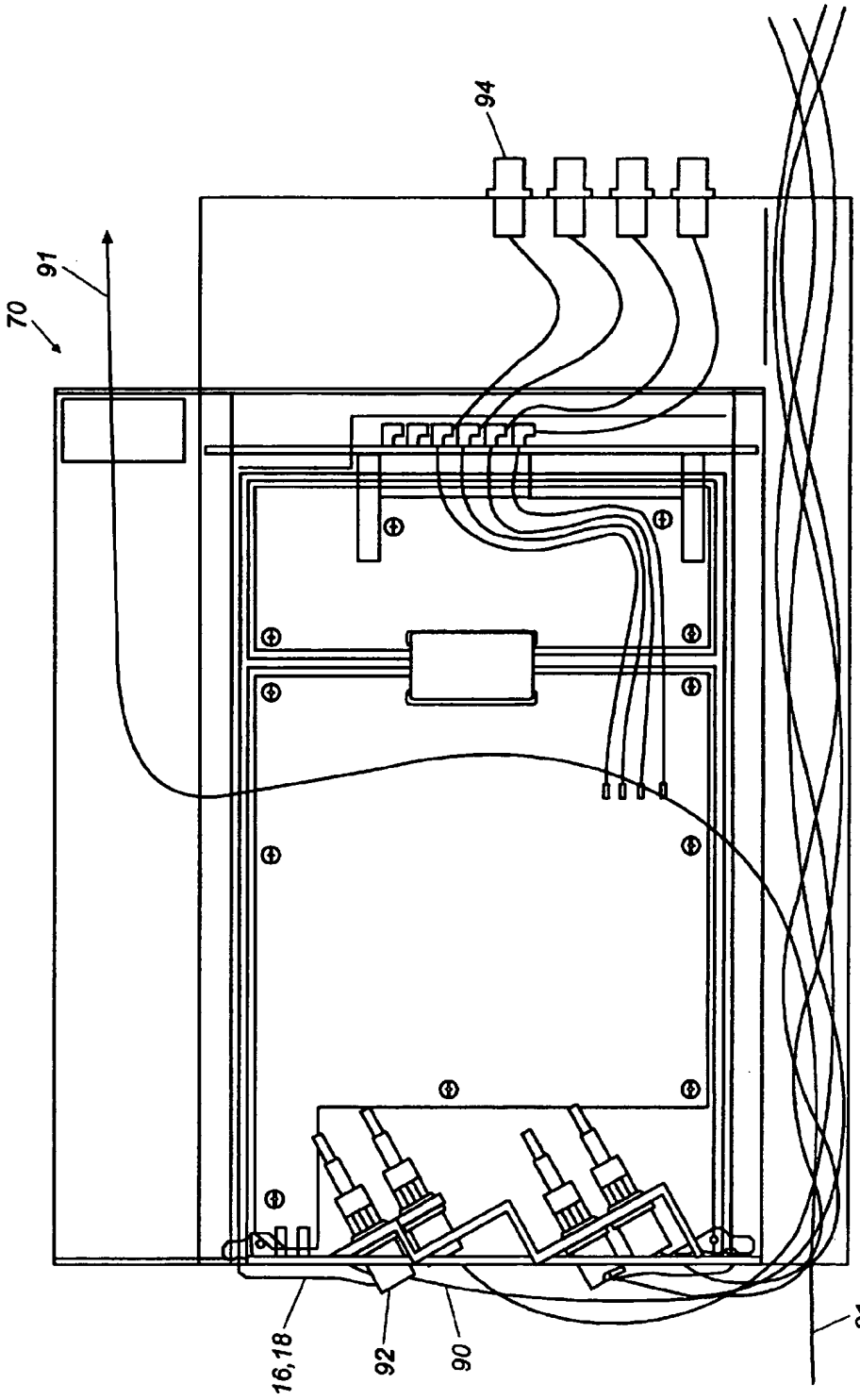


Fig. 5

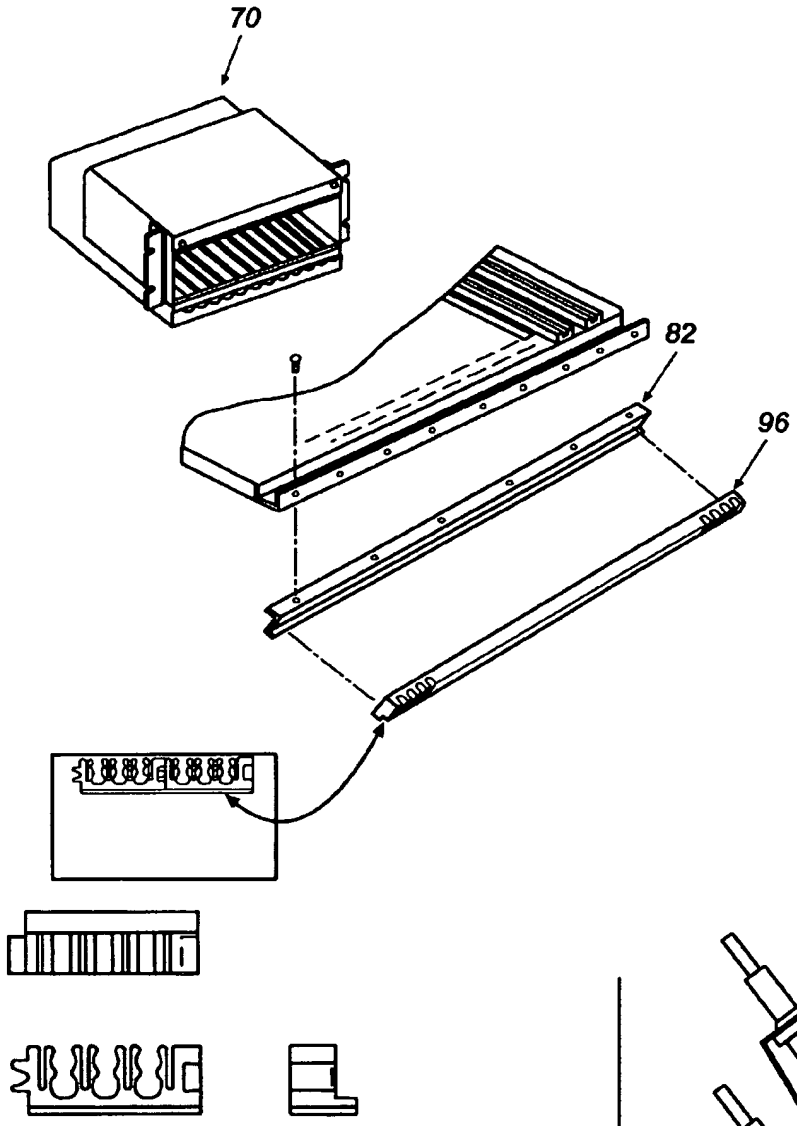


Fig. 6A

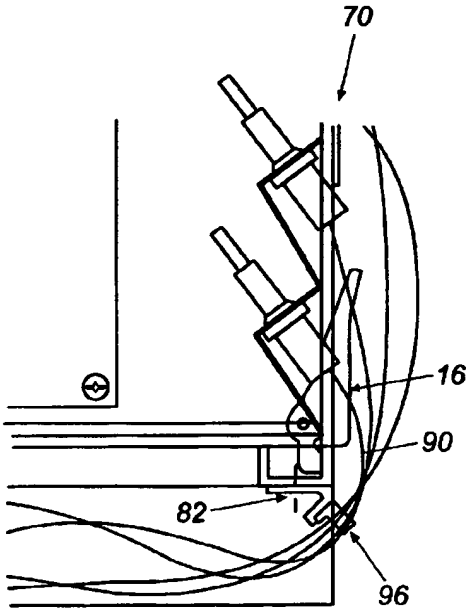


Fig. 6B

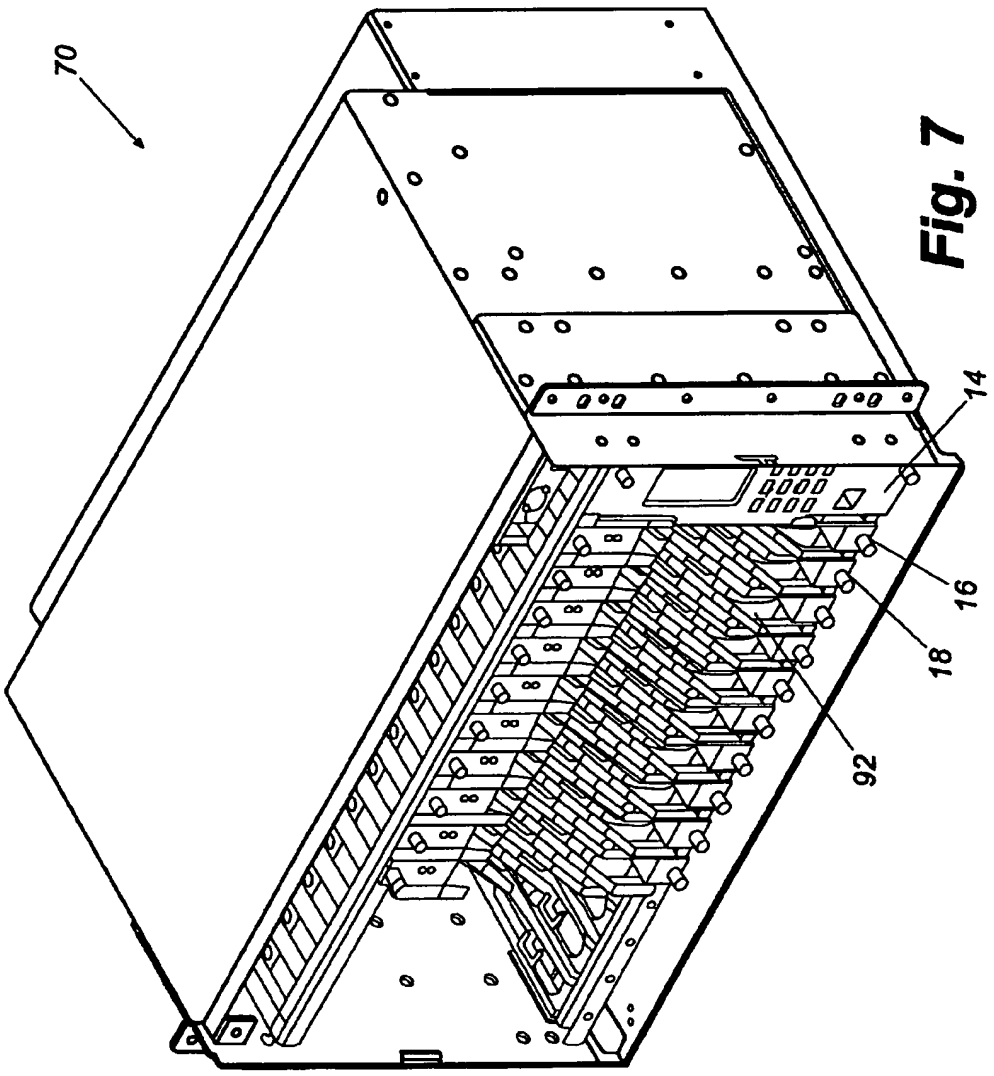


Fig. 7

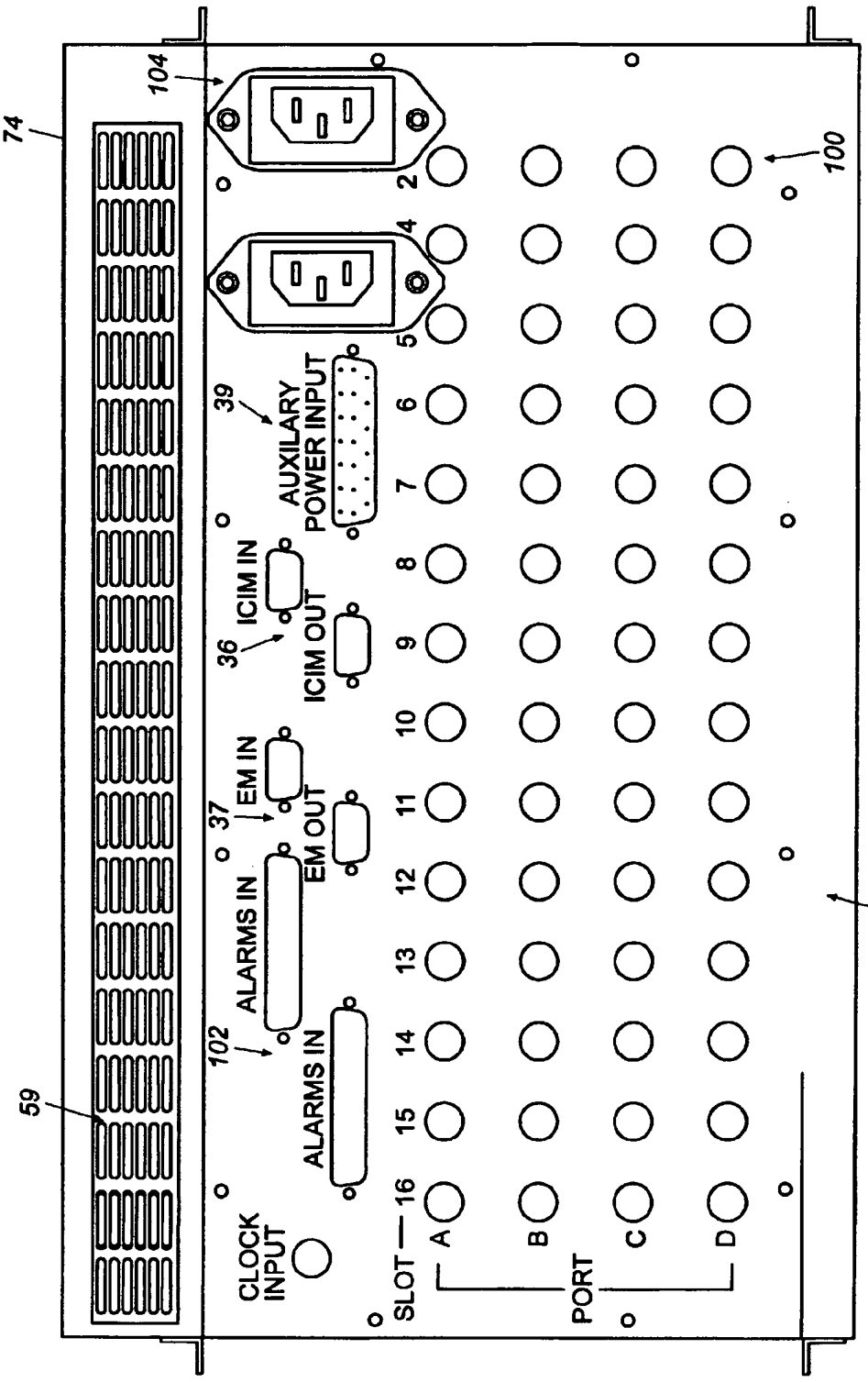

74
104
100
39
AUXILARY POWER INPUT
ICIM IN
36
ICIM OUT
EM IN
37
EM OUT
ALARMS IN
102
ALARMS IN
59
106
CLOCK INPUT
SLOT
PORT
A
B
C
D
2
4
5
6
7
8
9
10
11
12
13
14
15
16

Fig. 8

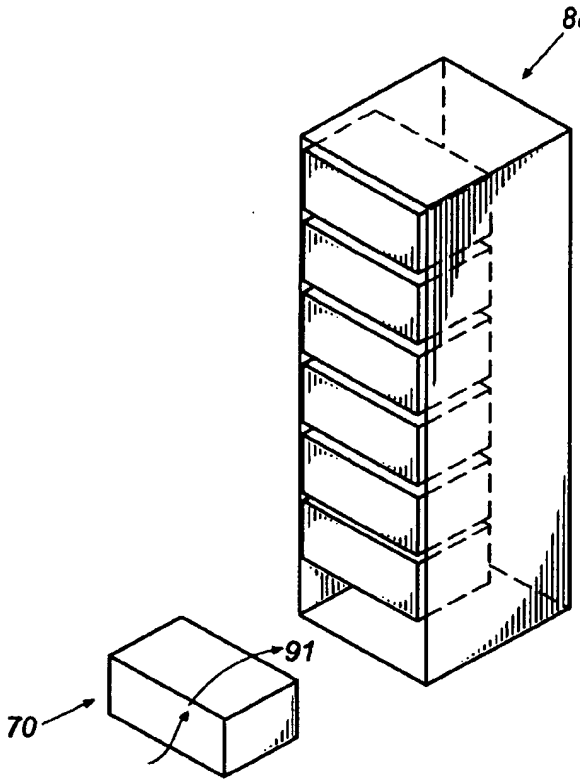


Fig. 9

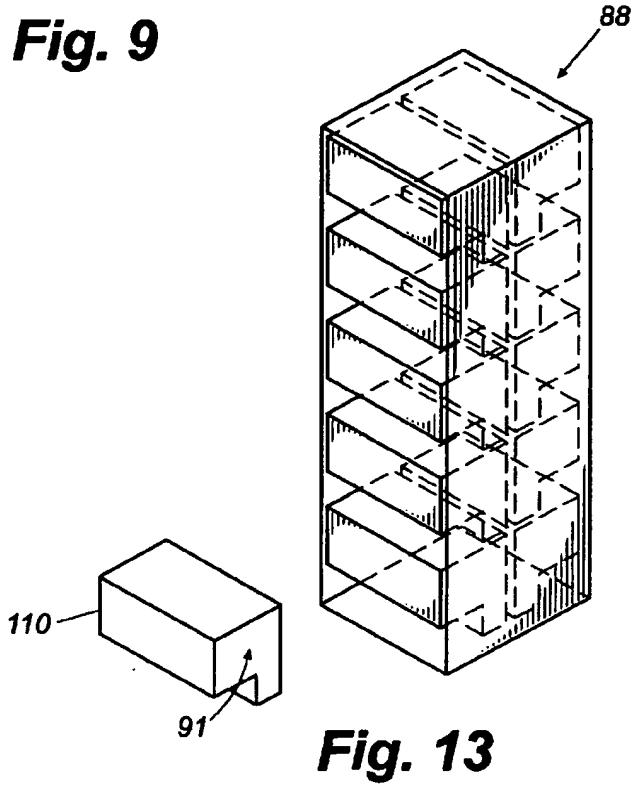


Fig. 13

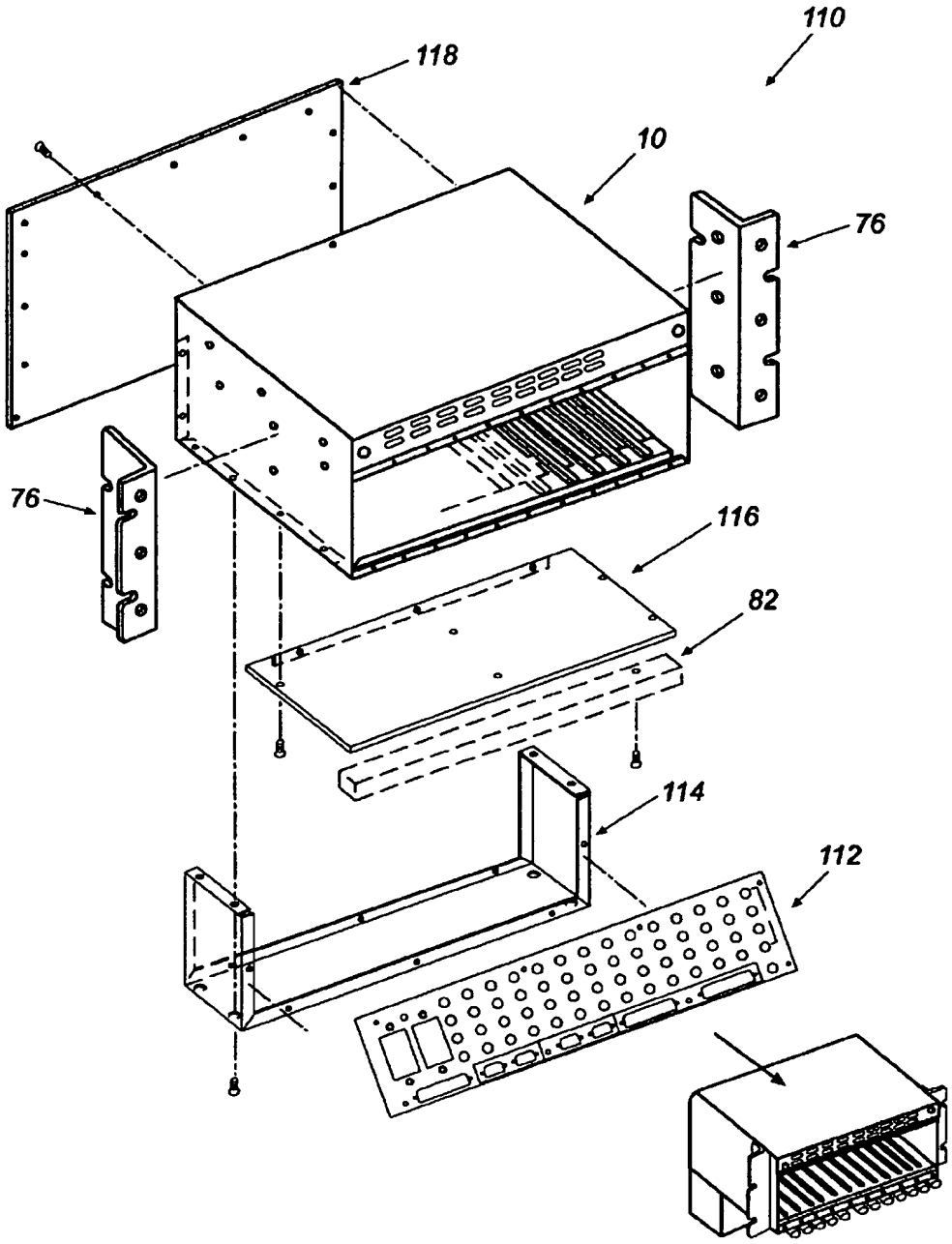


Fig. 10

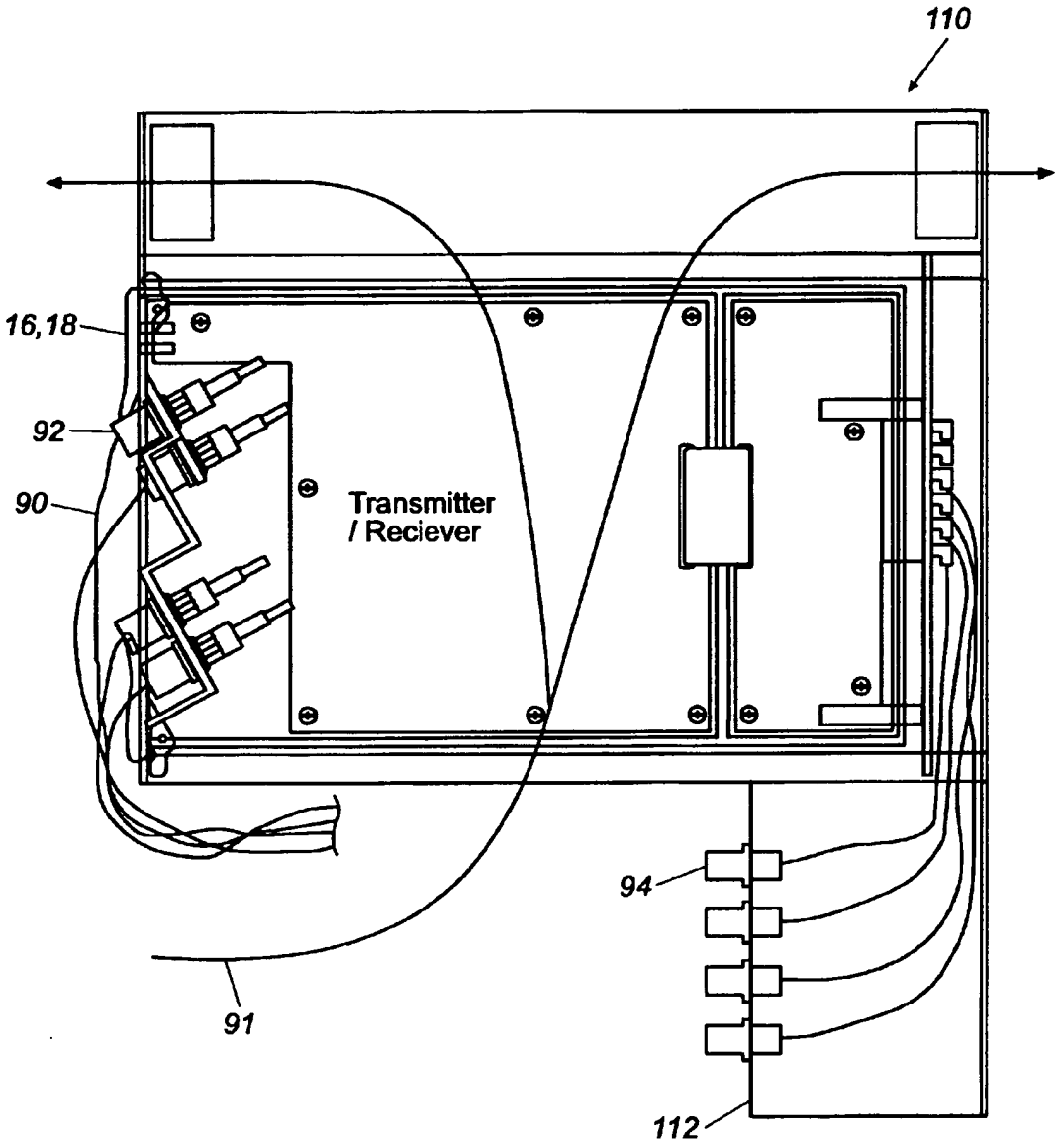


Fig. 11

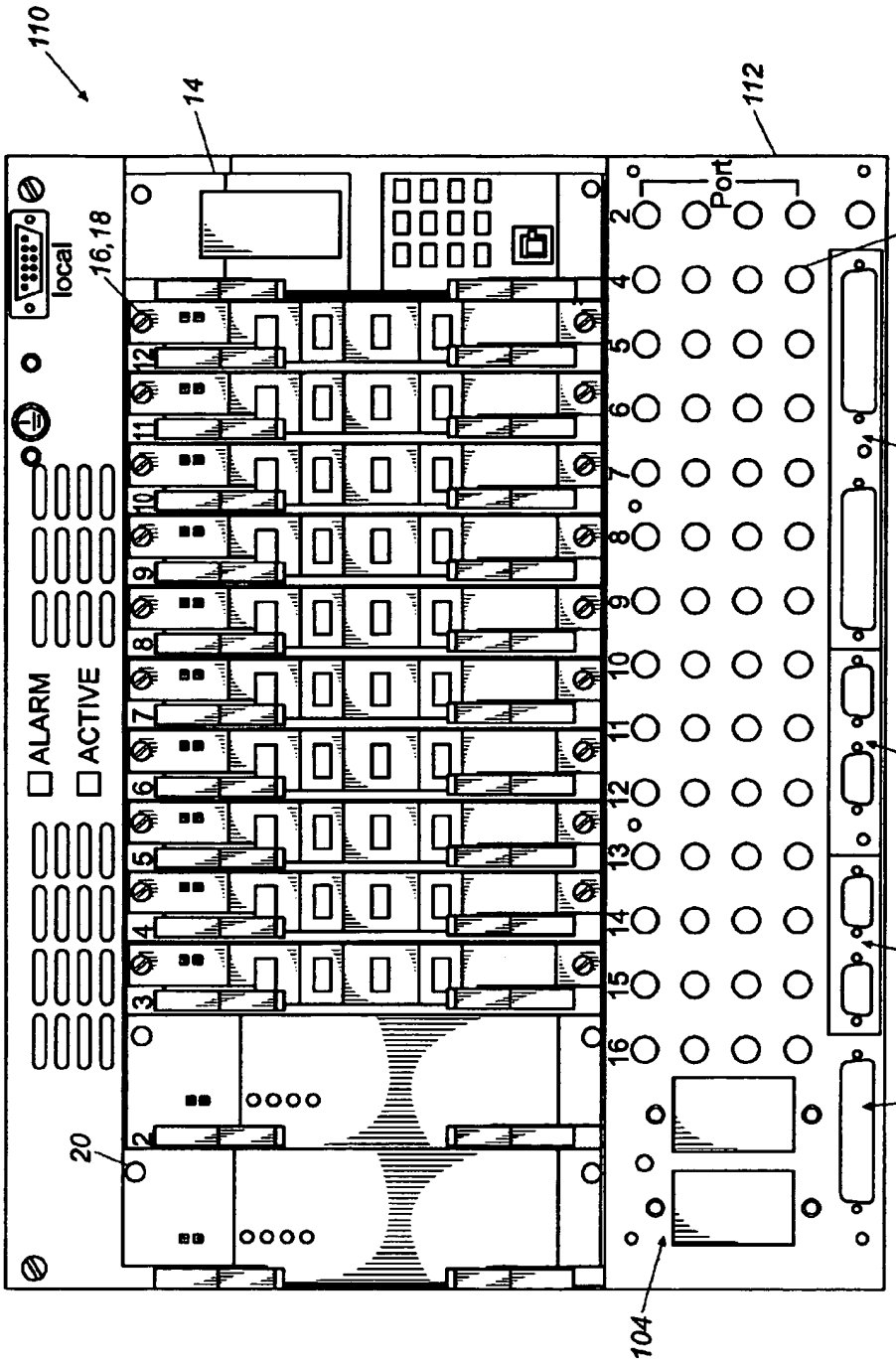


Fig. 12

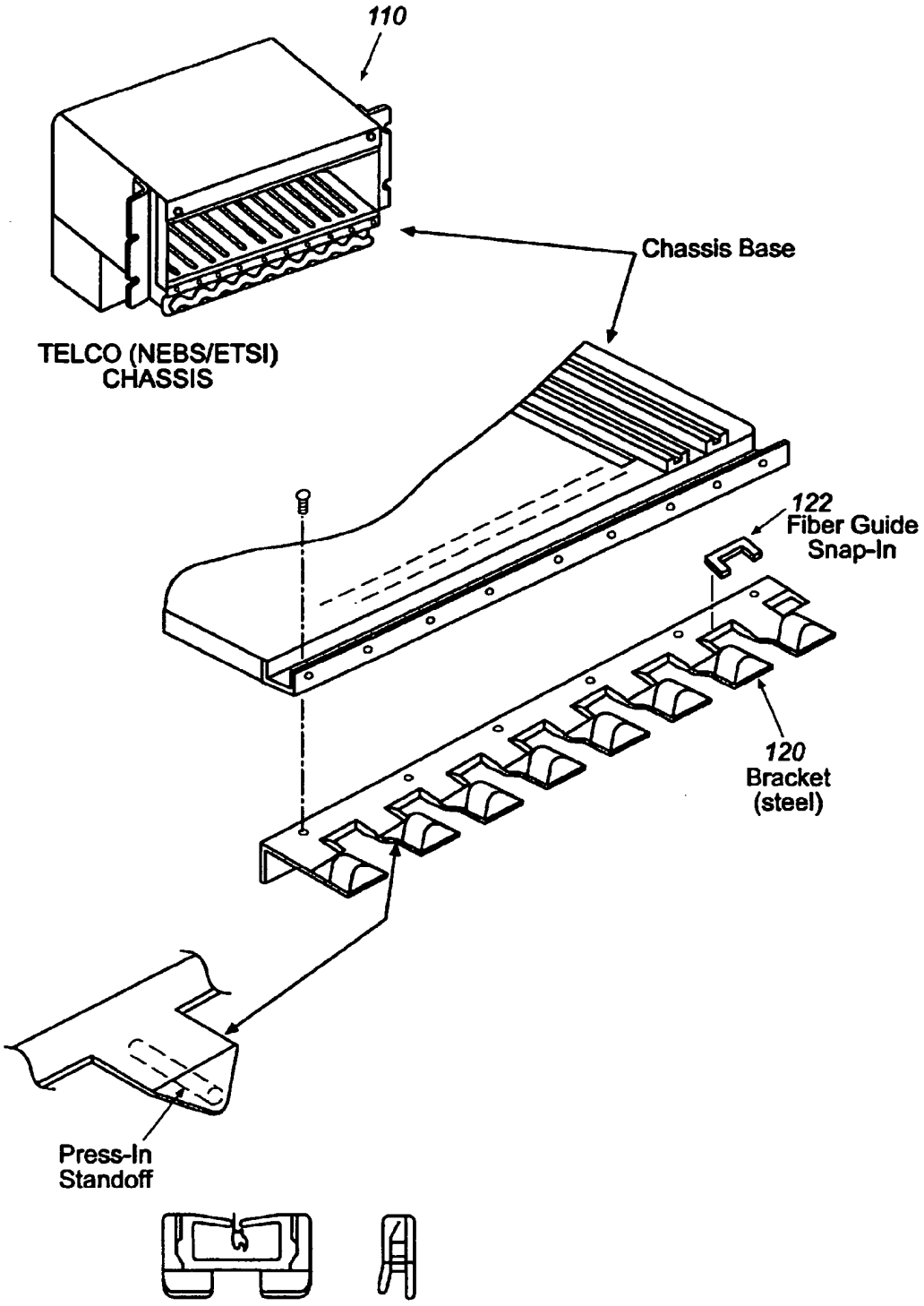

110
Chassis Base
TELCO (NEBS/ETSI)
CHASSIS
122
Fiber Guide
Snap-In
120
Bracket
(steel)
Press-In
Standoff

Fig. 14A

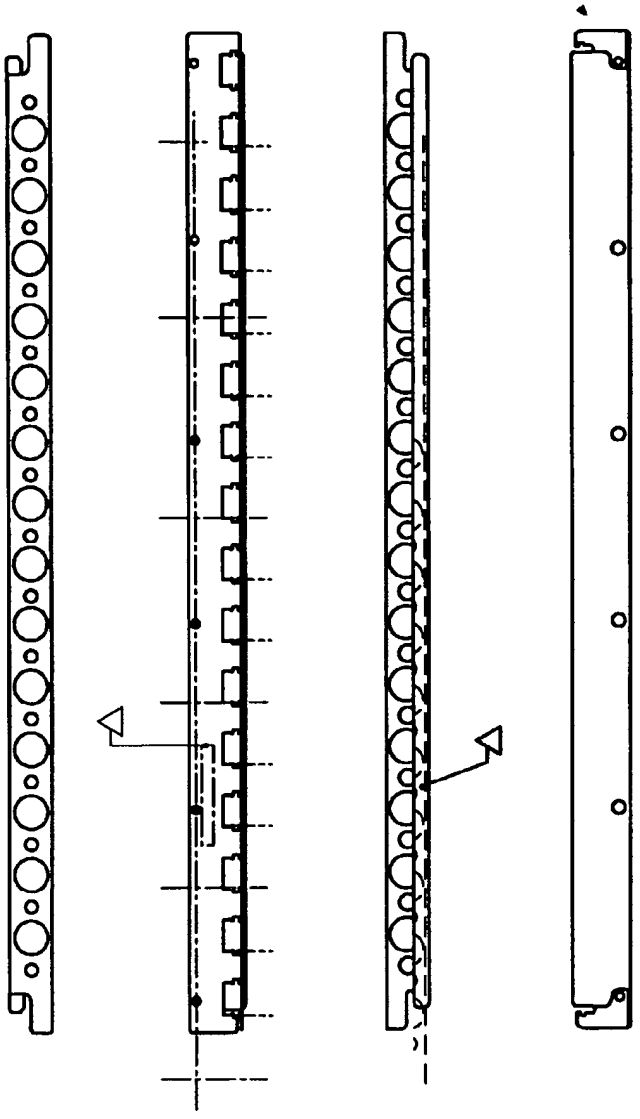


Fig. 14B

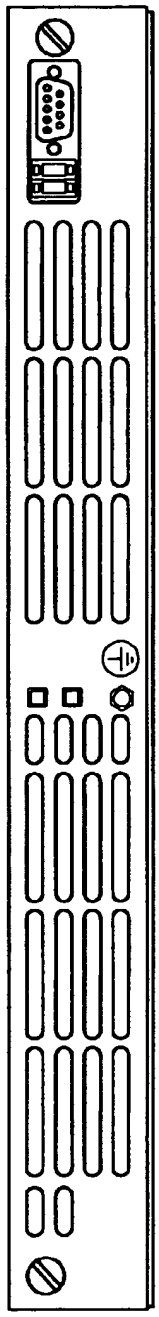


Fig. 16

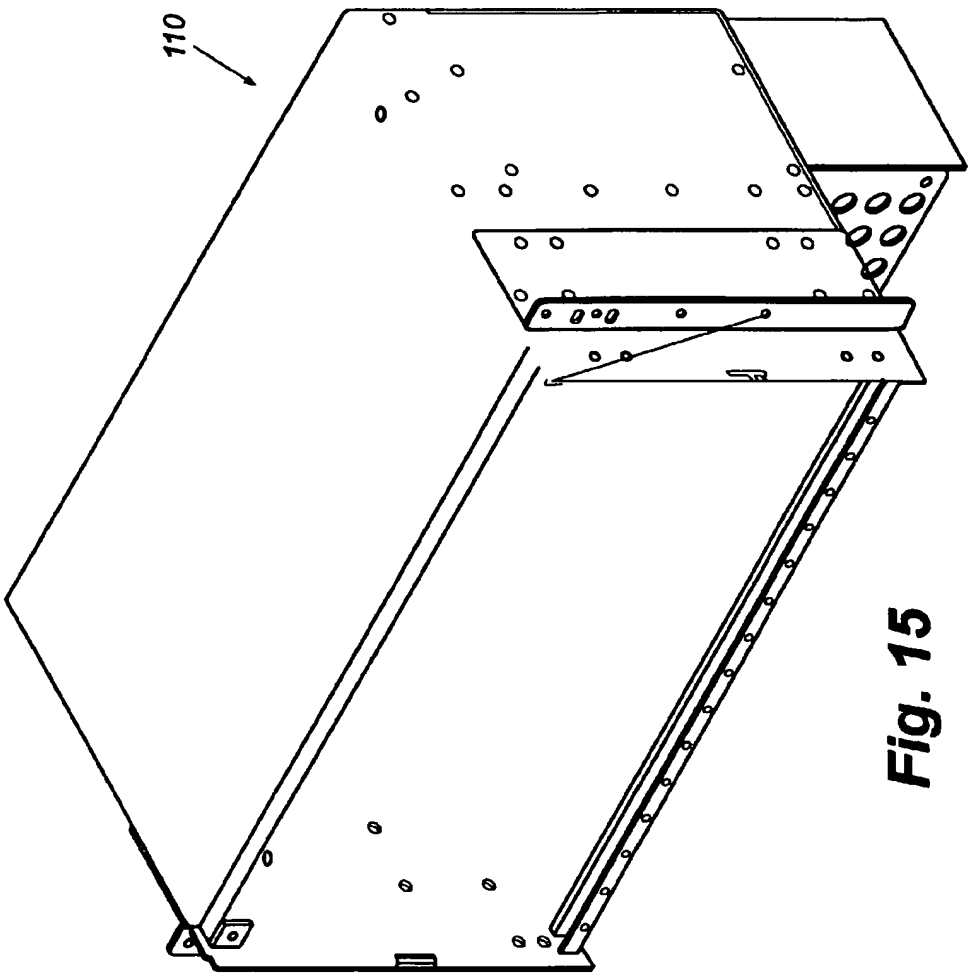


Fig. 15

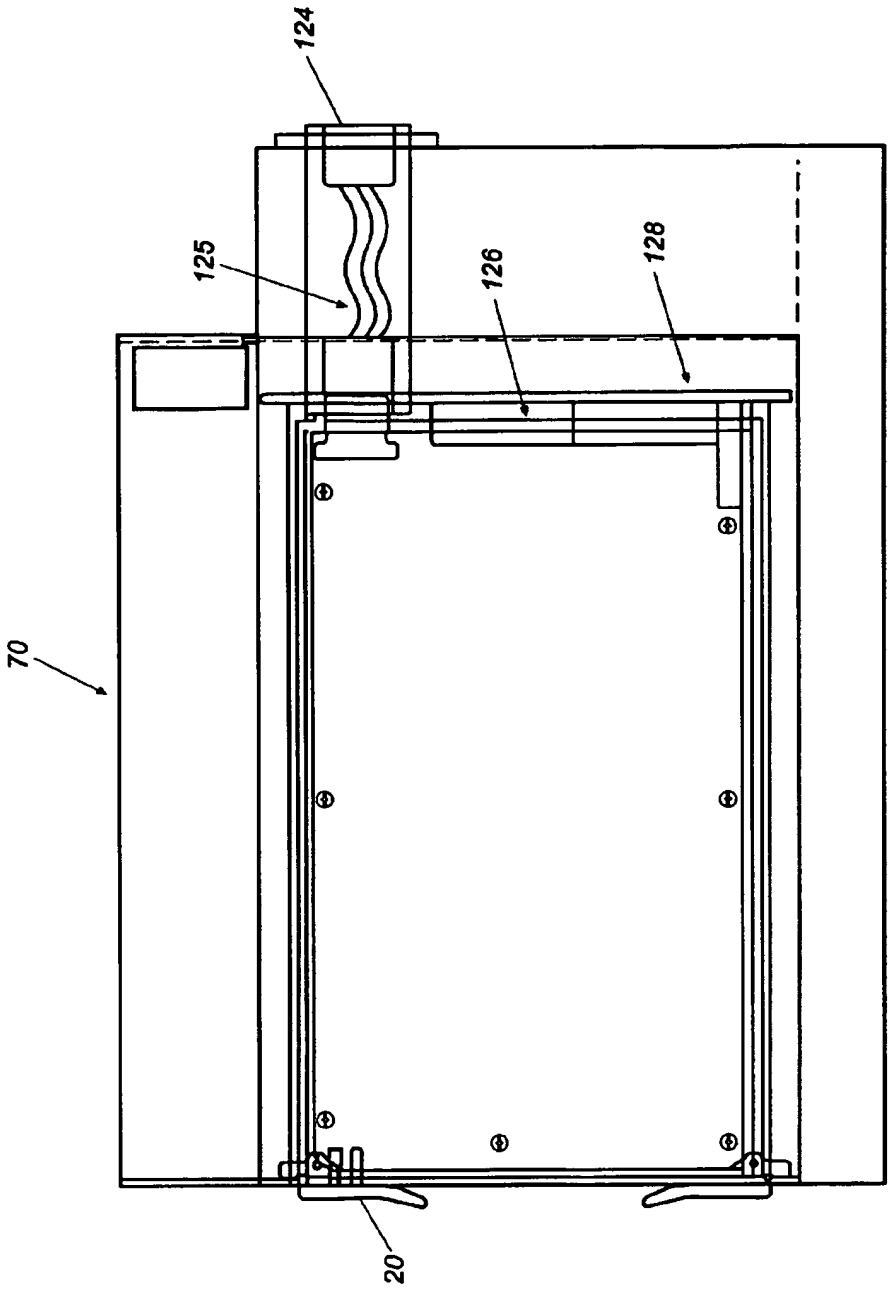


Fig. 17

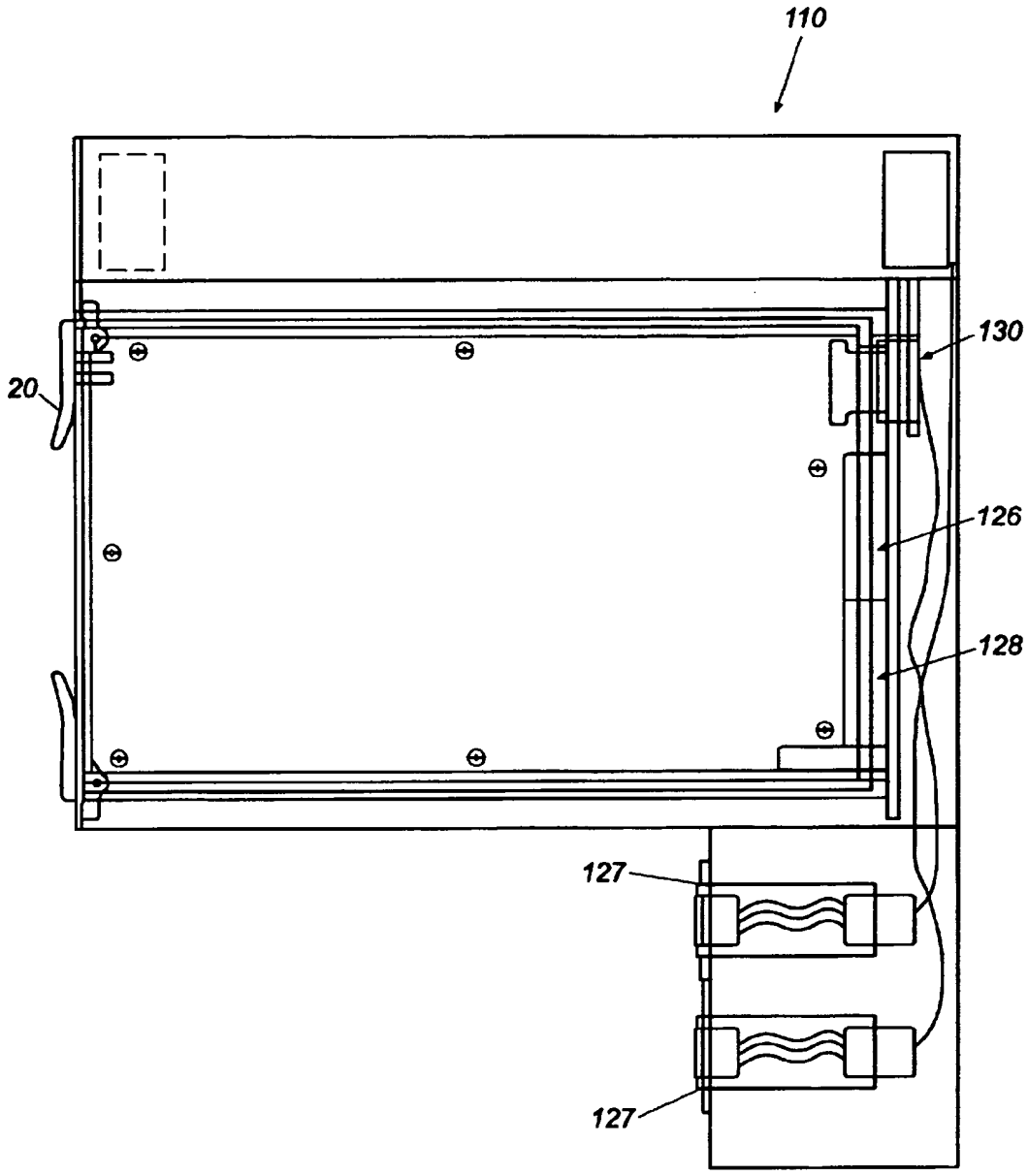


Fig. 18

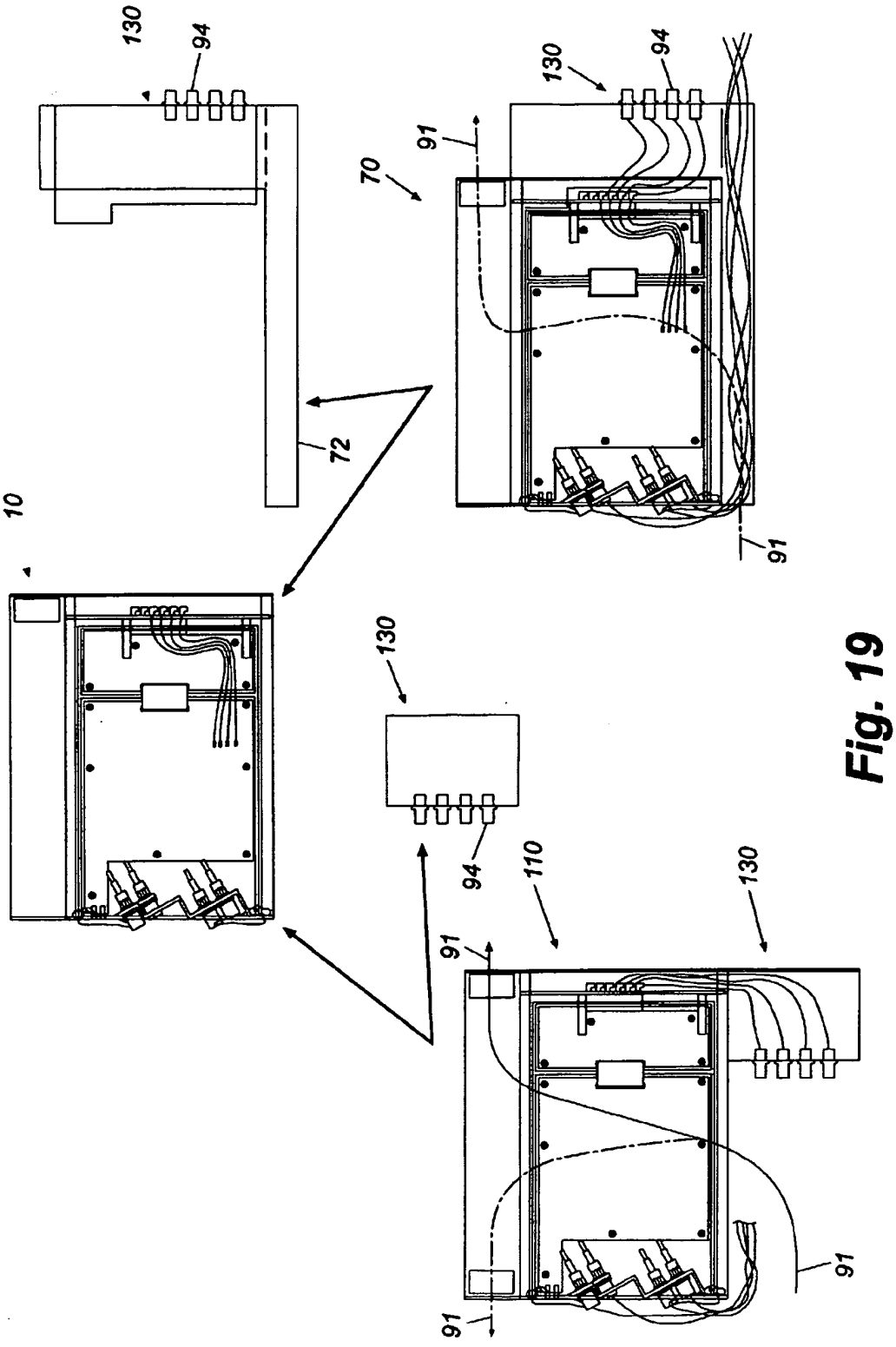


Fig. 19

UNIVERSAL CHASSIS FOR CATV HEADENDS OR TELECOMMUNICATIONS COMPANY CENTRAL OFFICE FOR OPTICAL ELECTRONIC EQUIPMENT

FIELD OF THE INVENTION

This invention relates to fiber optic connector modules, and, more particularly, to a dual configurable optical electronic equipment chassis having thermal design systems and methods for providing cooling air to the chassis.

BACKGROUND OF THE INVENTION

The cable television and telecommunications industries frequently utilize fiber optics as a transmission medium. Cable television (CATV) headends and central offices of a telecommunication company (Telcos) include numerous pieces of multi-function, fiber-dependent equipment. Fiber optic cables require special handling. Due to their brittle nature, excessive bending or twisting can damage the fibers, severely impair their functioning or break them altogether. Allowing fiber optic cables to become tangled or handling them like metal wire cables can also leave them susceptible to breakage or signal loss. Appropriate handling of the fiber optic cables within the cable headend or Telco improves service to customers and reduces expensive repairs or replacements.

By convention, cable companies and Telcos organize equipment modules by providing racks for holding the modules. The modules frequently fit within a box or chassis mounted onto the racks. Chassis often house optical electrical equipment such as transmitters, receivers, intelligent control interface modules (ICIM) and power supplies. A chassis configuration affords cable and Telco personnel easy access to the fiber optic cables (fiber) connected to various modules. Normally, modules slide into slots in the chassis. Fiber may route to and through the chassis. For example, a transmitter module design provides for inserting the module into a chassis having fiber optic connections along a front side of the chassis. Slots in the chassis hold additional equipment or devices, for example, a personal computer (PC) connection, fan trays, connectors for external devices and alarm indicators.

Equipment configured in modules and mounted in racks generate heat. A headend or central office might contain tens of racks of chassis utilized in providing services to customers. An individual rack can contain numerous chassis stacked one on top of another within the rack and, in the Telco market, the stacks may be arranged so chassis are back to back as well. Each chassis within the rack generates heat requiring dissipation. Telcos and cable providers rely on normal convection for cooling chassis in a rack. Optionally, a fan at the top of each chassis seeks to furnish supplemental cooling. But the stacked chassis result in a "chimney effect." The hot air exhaust is pulled by fans in higher chassis up the rack. This effect causes higher chassis to heat, rather than effecting the cooling the fans originally were intended to provide. Therefore, a more effective and efficient thermal management system for the chassis would contribute to the successful operation of the fibers and other equipment contained within the chassis.

Each chassis market has specific configuration requirements. The cable market chassis, referred to as the Multiple System Operator (MSO) chassis, requires fiber cable to route from the back of the chassis. The Telco market requirements differ between the U.S. and European markets (European Telecommunications Standard Industry, ETSI).

Both the U.S. Telco and ETSI markets require the fiber cable to route from the front of the chassis. Furthermore, due to stacking configurations, the U.S. Telco chassis must comply with the size requirement that it be no more than twelve inches deep, while the ETSI chassis must not exceed 280 mm. In contrast, the MSO chassis mounts vertically in a rack, meaning it cannot extend more than thirty inches deep. Chassis utilized in an MSO environment allow connections from the rear of the chassis.

Presently, to serve these differing chassis markets requires a different chassis for each market. This increases the costs of manufacturing, installation and maintenance. Therefore, a need exists for a chassis adaptable to the cable and Telco markets and provides thermal management in each configuration. The differences in approach among the Telco/CATV markets substantially complicate creation of a chassis that fulfills these objectives.

This invention provides for a reconfigurable chassis for holding electrical equipment. The chassis can be reconfigured to conform to telephone company industry standards or to cable television industry standards. The reconfigurable chassis provides for thermal management of external electrical modules that are inserted into the chassis and removed from the chassis, and the chassis includes a housing into which modules are inserted. The housing includes a front portion and a back portion and also has multiple guides for holding the modules.

The chassis further includes a removable fan tray located on top of the housing. The fan tray holds fans for cooling the modules held within the housing. The fans can be situated in a first position or in a second position. When the fans are located in the first position, air is directed from the front portion of the chassis. When the fans are located in the second position, air is directed from the back portion of the chassis.

A removable rear connector panel is also provided for use with the chassis. The rear connector panel is used when electrical cables coupled to the modules are to be accessed from the back portion of the housing. In this case, the removable rear connector panel is mounted to the back portion of the housing for electrically coupling to the electrical cables that are coupled to the modules.

A removable panel bracket is used with the chassis when the electrical cables coupled to the modules are to be accessed from the front portion of the housing, in which case the removable panel bracket is mounted beneath the housing for routing the electrical cables from the back portion of the housing to the front portion of the housing.

Along with the removable panel bracket, a removable front connector panel is used when the electrical cables coupled to the modules are to be accessed from the front portion of the housing. The removable front connector panel is mounted to the front portion of the housing for electrically coupling to the electrical cables that have been routed through the removable panel bracket.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** shows a front view of a basic chassis of this invention.

FIG. **2** shows a schematic, a rear view of the basic chassis of FIG. **1**.

FIG. **3** shows an exploded, perspective view of the basic chassis without modules.

FIG. **4** shows an exploded, perspective view of the basic chassis modified to a MSO chassis that supports the cable television environment.

FIG. 5 shows a side view of the MSO chassis with a module inserted therein.

FIG. 6A shows an exploded, perspective view of the MSO chassis having a fiber guide.

FIG. 6B shows a side view of the MSO chassis, transmitter module, fiber guide bracket and a fiber guide.

FIG. 7 shows a perspective, front view of the MSO chassis without a fan tray and power supplies.

FIG. 8 shows a rear view of the rear connector panel of the MSO chassis.

FIG. 9 shows a perspective, schematic view of MSO chassis mounted in a rack.

FIG. 10 shows an exploded, perspective view of the basic chassis modified to a Telco chassis that supports the telecommunications environment.

FIG. 11 shows a cut-away side view of the Telco chassis having a module inserted therein.

FIG. 12 shows a front view of the Telco chassis.

FIG. 13 shows a perspective view of multiple Telco chassis mounted in a rack.

FIG. 14A shows an exploded, perspective view of the Telco chassis having a fiber guide bracket with a snap-in plastic guide.

FIG. 14B shows schematic side views of alternative fiber guide brackets.

FIG. 15 shows a perspective view of a front view of the Telco chassis without modules or a fan tray.

FIG. 16 shows a front view of the Telco chassis vent holes.

FIG. 17 shows a side view of a MSO chassis with a modular power supply.

FIG. 18 shows a side view of a Telco chassis with a modular power supply.

FIG. 19 shows side cut-away views of the basic chassis and the Telco and MSO chassis configured from the basic chassis.

DETAILED DESCRIPTION

FIGS. 1–19 show a dual configurable optical electronic equipment chassis (the "basic chassis") and alternative embodiments of the basis chassis. The basic chassis can be efficiently modified to support chassis requirements for the cable television market (MSO) and chassis requirements for the U.S. and European telecommunications markets (Telco). Each market requires a distinct chassis configuration. The MSO market requires a chassis where the fiber optic cable (fiber) routes from the rear of the chassis and all other input/output (I/O) connections and air exhaust routes through the rear of the chassis. MSO chassis cannot extend more than thirty inches deep. By contrast, the Telco market requires the chassis to extend no more than twelve inches deep and routes the fiber, all I/O connections, and air exhaust from the front or rear of the chassis depending on the configuration used to mount the chassis. European Telcos expect the chassis to be no more than 280 mm deep with fiber routing, I/O connections and air exhaust through front of chassis, when chassis stack in a frame in a back-to-back configuration. The chassis of this invention with appropriate sub-assemblies configures to support the requirements of the cable industry, U.S. and European Telco markets.

Basic Chassis

FIG. 1 shows a front view of the basic chassis **10** of this invention. A front side **12** of the basic chassis **10** shows an illustration of modules supported by the basic chassis **10**. For example, modules compatible with the basic chassis **10** include Intelligent Control Interface Modules (ICIM) **14**, optical-electroptical equipment such as transmitters **16** and receivers modules **18**, and modular power supplies **20**. The basic chassis accommodates fourteen transmitters/receiver single slot modules **16, 18** when two power supplies **20** are utilized with the chassis. A single slot or blank module configuration may be substituted for a power supply. There are twelve slots for transmitter/receiver modules **16, 18** slots when an ICIM **14** is installed; there are ten slots when an ICIM **14** and any redundant modules are installed. Additionally, the chassis supports other modules, including radio frequency (RF) driver amplifiers, receivers, transmitters, externally modulated transmitters (EMTs), erbium-doped fiber or other amplifiers (EDFAs) optical switches, RF switches and digital reverse modules. An ejector system **17** provides for controlled insertion and extraction of the modules **14, 16, 18** and **20**. The front side **12** of the basic chassis **10** supports a connection for a personal computer (PC) **22** and indicators such as a fan alarm indicator **24**.

FIG. **2** shows a rear, schematic view of the basic chassis **10**. The basic chassis includes a backplane **30**. The chassis backplane **30** distributes the power supply voltages **32**, a common serial bus, the high speed data bus to the ICIM **36**, and four discreet external (coax) connections **38** to each of the module connectors (with the expansion capability of six). The common serial bus includes a series of wire traces within the backplane **30** that connects to all of the connectors and hence common to all module slots. The backplane **30** provides a passive circuit card assembly. A mechanical ID device attaches to the back plane **30**. The mechanical ID device provides a number identification such as a mechanical/electrical ten position switch to the backplane **30** set (with a unique number) to each chassis during installation. That unique number allows the ICIM to control multiple chassis (e.g. one ICIM may control six or more chassis).

The connectors **38** utilized for interconnection to the modules include Hard Metric 2 mm pitch, IEC 917 and IEC 1076-4-101 or equivalent series and accommodate power, digital signals and coaxial signals. The connectors **38** are inherently self-guiding and allow blind mate connection. These connectors **38** reduce insertion and withdraw forces when inserting or removing modules as compared to existing devices. As configured, the connectors **38** provide four coax interconnections to the module and optionally six coax interconnections, and **110** signal/power pins. The connectors on the top of the back plane encompass cable assemblies that plug into the backplane connectors. These cable assemblies route to either the Telco chassis front side or a back side of the MSO chassis.

FIG. **3** shows an exploded, perspective view of the basic chassis **10** without modules. The basis chassis **10** includes the front side **12**, the backplane **30**, two sides **40, 42**, a top **44** and bottom **46**, a fan tray **48**, and a shelf **50**. The bottom **46** and two sides **40, 42**, attach forming support for the basic chassis **10**. The backplane **30** includes the connections shown in FIG. **2**; however, for illustrative purposes, FIG. **3** shows only a few connectors **38**. The bottom **46** of the basic chassis **10** includes a plurality of grids **52** on an upper portion **54** of the bottom **46** for guiding the modules into the basic chassis **10**. The shelf **50** includes a plurality of grids **52** that cooperate with the bottom **46** for receiving modules. The shelf **50** attaches to the two sides **40, 42** and the backplane **30** attaches to the shelf **50**.

The basic chassis **10** provide for ease of mounting in either a cable television environment or central office of a

telecommunications company. Modules slide into the basic chassis **10** from the front side **12** of the basic chassis **10** and are guided by plastic module guides **52**. Blind mate connection is made with the motherboard. Modules can have optional guide or ground pins installed for increased alignment. The modules will be secured and removed via ejector levers **17** (See FIG. **1**). Modules will be hot installable and may be grounded directly to the basic chassis **10** by captive screws on the front of the modules. The modules/chassis injector design and self-aligning connector platform allow for minimal insertion and withdrawal forces. Fiber enters the module from the front side **12** of the basic chassis **10**. Some modules accommodate up to four or more SC/APC type optical connectors or potentially other type connectors on the front side **12**. SC/APC type optical connectors meet industry standards for optical connectors utilized for fiber cable connections to modules.

Fan tray **48** positions on top of the shelf **50**. Top **44** slides into position above the fan tray **48** and attaches to fan tray **48** and the two sides **40, 42** and backplane **30**. Top **44** includes a rear portion **57** having a plurality of vents **59**. The fan tray **48** holds a printed wiring board including a fan interface and monitoring circuit board assembly **58**. Assembly **58** includes filtering, fan connections, an alarm LED connection, and an interconnect with backplane cable assembly **60**. A bank of fans **62**, such as tube fans, on the fan tray **48** may cooperate with the vents **59** in the top **44** provide for directing air out of the basic chassis **10**. The removable fan tray **48** houses the fans **62** for ease of maintenance. Fans **62** may be held in one of multiple locations or fan tray **48** by vents **59**. In one embodiment, at least one fan **62** is adjustable to exhaust air from the chassis **10** via a selected path.

Note, however, that fans **62** could be affixed to the tray by clips, adhesive, straps or other mechanical fixtures. Likewise, fan tray **48** could take any form that would readily hold fans **62** in an adjustable matter. Thus, instead of multiple fan-shaped vents **59**, fan try **48** could simply have a number of parallel slots to which fans **62** could be removably or slidably attached.

The basic chassis **10** can be constructed from aluminum and steel. The parts can be assembled utilizing for example, screws or rivets. The fan tray **48** may be masked and painted. The rest of the parts may have clear coat conversion coating, for example, silver or brushed aluminum color.

This invention provides for thermal management of the chassis **10**. The fan **62** bank of this invention provides significantly more cooling air with a uniform distribution of air between the modules. A negative crusher fan system pulls input cooling air from the cable headend or central office environment rather than from inside the rack area. The dye cast or sheet metal modules have a heat sink surface along the side, providing more cooling surface area, rather than on the module rear. The sheet metal chassis **10** exhausts air through vent holes **59**. Air draws in from the bottom side **46**. This design ensures the positive cooling effects of increased air flow and less restriction of air flow through the chassis.

As discussed below, the basic chassis **10** rear exhaust fan system supports the MSO environment while the basis chassis **10** easily modifies to a front exhaust fan tray for use in Telco chassis. Preferably, this invention provides for an indefinite fan operation. For example, operation continues if one fan **62** fails. Further, this invention provides for a ten minute guaranteed operation when replacing the fan tray **48**.

This invention aims to achieve basic chassis **10** heat dissipation of about 240 watts. In a six chassis rack configuration this heat dissipation meets or falls within the Network Equipment Building Standards (NEBS) BellCore GR-63-Core guidelines for 24-inch deep racks of 1,450 watts per rack.

Optionally, a door fits over the front side **12** of the basic chassis **10**. The door includes vent holes positioned adjacent to the fans **62** for air exhaust and provides additional protection from electromagnetic fields.

MSO Chassis

FIG. **4** shows an exploded perspective view of the basic chassis modified to a MSO chassis **70** that supports the MSO environment. The MSO chassis **70** encompasses the basic chassis **10** modified to comply with headend configuration, size and mounting requirements. The size of the MSO chassis **70** is approximately 17 inches wide by 14 inches deep with an overall height of about 10.50 inches and weighs about 20 pounds. The MSO chassis **70** includes the basic chassis **10**, a fiber tray subassembly **72**, a cable interface housing having a rear connector panel **74**, mounting flange brackets **76**, support brackets **78**, and fiber guide brackets **82**. The construction materials, assembly and finish for the MSO chassis **70** corresponds to the basic chassis **10**.

MSO chassis **70** may be assembled as follows. First, the support bracket **78** attaches the basic chassis **10** to the fiber tray sub-assembly **72** creating the MSO chassis **70**. Fiber guide bracket **82** is positioned between the basic chassis **10** and an upper front portion **84** of the fiber tray sub-assembly **72**. The rear connector panel **74** attaches to the rear of the fiber tray sub-assembly **72** providing access to connections such as RF coax connections, power hook ups, alarms, and ICIM interfaces at the rear of the chassis **70**. Mounting brackets **76** attach the MSO chassis **70** to a rack **88**.

FIG. **5** shows a side view of the MSO chassis **70**, outfitted with a transmitter **16** or receiver **18** module. The MSO chassis **70** allows fiber entry from the rear or front. The fiber **90** attaches to a connector **92** on the transmitter module **16** or receiver module **18**, and then the fiber **90** routes underneath the basic chassis **10** guided by the fiber guide bracket **82** onto the fiber tray sub-assembly **72** out the rear of the MSO chassis **70**. Fans **62** move the air exhaust **91** from the front of the MSO chassis **70** to the top for exhaust out the rear. Connectors **94** coupled to the housing **130** allow for rear access to RF coax connections.

FIG. **6A** shows the MSO chassis **70** with a fiber guide **96**, which may be formed of plastic. As fiber **90** routes to the front it can be clipped to fiber guide **96** retainers attached to the fiber guide bracket **82**. FIG. **6B** shows a side view of the MSO chassis **70**, transmitter module **16**, fiber guide bracket **82** and the fiber guide **96**. The fiber guide **96** keeps an appropriate bend in the fiber **90** limiting signal deterioration. The removable assembly of fiber guide bracket **82** and fiber guide **96** may be utilized with other configurations, for example the Telco chassis.

FIG. **7** shows a perspective, front view of the MSO chassis **70** without a fan tray **48** and modular power supplies **20**. This view shows attachment of an ICIM module **14**, transmitter modules **16** and/or receiver module **18** to the MSO chassis **70**. Fibers **90** can attach to the transmitter module at connector **92**.

FIG. **8** shows a rear view of the rear connector panel **74** of the MSO chassis **70**. Like the rear of the basic chassis **10**, the MSO chassis **70** includes a plurality of connectors **100**, such as, ICIM control **36**, Ethernet connections **37**, redundancy control alarms **102**, power supplies **104** and auxiliary power **39**. A passageway **106** allows fiber **90** entry from the rear as well as entry from the front of the MSO chassis **70**. Air exhausts **91** out of the MSO chassis **70** from the vents **59** located close to the fans **62** at the top rear of the MSO chassis **70**.

In the MSO chassis **70**, modular power supplies connect at the rear of the chassis. The modular power supply **104** (AC-MPS) connects to an adapter that houses the AC line cord input. When a DC-MPS is used, a similar DC adapter is utilized having a terminal block for input. The overall size of the power supply for the MSO chassis **70** includes a height of about 6.5 inches, a length of about 10 inches and a two-inch width. Power (various DC voltages) distributes via backplane connector **38** (shown in FIG. **2**) through IEC 917 and IEC 1076-4-101 compatible power connectors and signal connectors from input connectors **32**.

A frame or rack **88** holds up to six stacked MSO chassis **70**. The six-unit configuration allows the front or rear fiber **90** routing and rear RF coax connections **94**. Like the basic chassis **10**, an optional front door may be placed on the MSO chassis **70**.

FIG. **9** shows a perspective, schematic view of a rack **88**. The chassis design allows rack mounting in either open or enclosed 19 inch or 24-inch wide cabinets or racks per Electronic industries Association (EIA) Specification RS-310-C. The MSO chassis **70** supports a loaded weight of 150 pounds utilizing the mounting ears or mounting brackets **76** for support in either the open or enclosed rack **88** configuration. A standard six-foot (also referred to as a **40** unit standard rack) rack **88** support six MSO chassis **70**. A chassis mounts to a rack **88** via removable mounting ears, or mounting brackets **76**, attached to the side of the chassis. When mounted in an enclosed rack **88** having internal side attachment areas, the chassis accommodates the use of rack **88** or chassis support rails. In this configuration, air exhausts along path **91** from a lower front portion of the MSO chassis **70** and out of the rear of the chassis. In yet another embodiment, fans **62** exhausts the air out of the chassis **70** along a path directed away from other chassis **70** within the rack **88**.

Using the present invention, the so-called chimney effect can be substantially eliminated. That goal is achieved by directing exhaust from each chassis along paths that do not intersect with air flow entering adjacent or other chassis within the rack **88**. FIG. **9** shows one such possible exhaust path **91**, although other paths are possible.

Telco Chassis

FIG. **10** shows an exploded, perspective view of the basic chassis modified to a Telco chassis **110** that supports the Telco environment. The Telco chassis **110** includes the basic chassis **10** modified to comply with U.S. and European Telco configuration, size and mounting requirements. The size of the U.S. Telco chassis **110** is approximately 17 inches wide by 12 inches maximum deep by about 14 inches tall and weighs approximately 20 pounds. The ETSI chassis requires the chassis extend no longer than eleven inches. The construction materials, assembly and finish are the same as for the basic chassis **10**.

The Telco chassis **110** includes the basic chassis **10**, a connector panel sub-assembly including a front connector panel **112**, a housing **130** (shown also in FIG. **19**) having a panel bracket **114** and a vent bracket **116**, mounting flange brackets **76**, and fiber guide bracket **82** and a rear cover **118**. In the Telco chassis **110**, all connections reside on the front of the chassis **110**. The fans **62** are positioned on the front of the fan tray **48** for front air exhaust. Vents **59** located in a front portion of the fan tray **48** provide for air exhaust **91**. The Telco environment requires front air exhaust **91** since the Telco chassis **110** typically mount in a frame or rack **88** in a back-to-back configuration. In another embodiment, the Telco chassis **110** exhausts air from the rear when vertically stacked in a rack **88**. In yet another embodiment, fans **62** exhausts the air out of the chassis **110** along a path directed away from other chassis **110** within the rack **88**.

FIG. **11** shows a cut-away side view of the Telco chassis **110** having a transmitter (or receiver) module inserted therein. A plurality of modules such as transmitter **16** and receiver **18** modules, ICIM modules **14**, and power supplies **20** insert into the basic chassis **10** portion of the Telco chassis **110**. Fiber **90** routes from the module connectors **92** through the fiber guide bracket **82** or **120**. The Telco chassis **110** provides for RF coax connections **94** from the front connector panel **112** of the housing **130**. Exhaust air **91** entering from the front of the Telco chassis **91** can be exhausted out the front or rear of the chassis **91**. A top rear air exhaust is utilized when Telco chassis **110** are mounted in a back to back configuration in a rack **88**.

FIG. **12** shows a front view of the Telco chassis **110**. This view shows an ICIM module **14**, transmitter modules **16** and/or receiver module **18**, power supplies **20** and connectors **92** attached to the Telco chassis **110**. The front of the Telco chassis **110** provides for a plurality of connectors **100**, ICIM control **36**, Ethernet connections **37**, redundancy control alarms **102**, power supplies **104** and auxiliary power **39**. Like the basic chassis **10**, an optional front door may be placed on the Telco chassis **110**.

FIG. **13** shows a perspective view of a rack **88**. The Telco chassis **110** design allows rack mounting in either open or enclosed 19 or 23 inch wide cabinets or racks per NEBS BellCore GR-63-Core standard, 19 or 24 inch wide cabinets or racks per EIA Specification RS-310-C, or 535 mm wide cabinets or racks per ETS 300 119-3. A standard six-foot (also referred to as a 40 unit standard rack) rack **88** can support ten Telco chassis **110** arranged in a back-to-back configuration shown in FIG. **13**. The Telco chassis **110** fits within a standard frame when stacked five units tall. Stacking of the Telco chassis **110** five units high allows for front fiber and front RF coax connections. Cable routing and power connections are also from the front side of the Telco chassis **110**. Air intake for the chassis is from the front bottom and exhaust is at the top rear in a stacked configuration; and if the chassis are arranged in the back-to-back configuration, from the front via the exhaust fan tray **48**. Again, like in FIG. **9**, the exhaust path from chassis **110** has been arranged so as not to intersect with air flowing into other chassis **110** in rack **88**. This effectively limits or eliminates the chimney effect. The Telco chassis **110** supports a loaded weight of 150 pounds utilizing the mounting ears or mounting brackets **76** for support in either the open or enclosed rack configuration.

FIG. **14A** shows an exploded, perspective view of the Telco chassis **110** having a fiber guide bracket **120** with a snap-in plastic guide **122**. FIG. **14B** shows schematic side views of alternative fiber guide brackets **120A**, **120B**, **120C**, and **120D**. Fiber **90** routes to the front of the Telco chassis **110** through the fiber guide bracket **120** allowing for cable separation and control of fiber **90** radius bends.

FIG. **15** shows a perspective, front view of the Telco chassis **110** without modules or a fan tray **48**. This view shows how an ICIM module **14**, transmitter modules **16** and/or receiver module **18** can be attached to the Telco chassis **110**.

FIG. **16** shows a front view of the Telco chassis **110** vent holes. In one embodiment, the Telco chassis **110** positions fans **62** at the front of the fan tray **48**. Air exhaust **91** in a Telco configuration expels from the rear of the Telco chassis **110** or from the front for back to back rack **88** configurations.

Modular Power Supplies

Modular power supplies **20** insert from the front of the chassis. Both the MSO chassis **70** and Telco chassis **110** can

utilize AC and DC modular power supplies. As discussed above, inputs for auxiliary power reside on the chassis connector panels. Generally, an adapter, such as a MPS adapter, is positioned behind the modular power supply **20**, allowing connection and flexibility to supply a customer with an AC power supply or a DC power supply. The adapter is used with appropriate supply to allow AC or DC inputs and also allows "hot swap" capabilities. After positioning the adapter into place in the chassis, either the modular power supply **20** is directly connected to the chassis (MSO chassis **70**) or a cable assembly connects to the power supply and then to the adapter (Telco chassis **110**).

FIG. **17** shows a side view of a MSO chassis **70** with a modular power supply **20**. In the MSO chassis **70**, power connections **124** extend from the rear of the MSO chassis **70**. When utilizing an AC-MPS, the modular power supply **20** connects to an adapter **125** that houses the AC line cord input. When a DC-MPS is used, a similar DC adapter is utilized that has a terminal block for input. Various DC (voltages) distributes via rear panel connector **74** through AMP Z-PACK power connectors **126** and signal connectors **128**. The power supply for the MSO chassis **70** is about 6.4 inches high, and 10 inches long and 2 inches deep.

FIG. **18** shows a side view of a Telco chassis **110** with a modular power supply **20**. In the Telco chassis the AC-MPS modular power supply **20** connects to an internal panel mount cable assembly **130** that plugs into the AC input adapter **125**. The AC input adapter **127** mounts on the front of the Telco chassis **110** (instead of the rear as in the MSO chassis **70**) When a DC-MPS modular power supply is utilized, a similar DC adapter **127** having a terminal block input mounts on the front of the Telco chassis **110**.

FIG. **19** shows side cut-away views of the basic chassis **10** and the Telco and MSO chassis **70, 110** configured from the basic chassis. The basic chassis **10** of FIGS. **1–4** easily reconfigures to support the Telco and CATV markets. As shown in FIG. **19**, a reconfigurable housing or cable interface assembly **130** adapts for use with the Telco chassis **110** and the MSO chassis **70**. For example, the housing **130** adapts from a first position to second position on the chassis **10**, reconfiguring the chassis **10** to support the Telco or CATV market. In the Telco chassis **110**, the connectors **94** reside on the front of the housing **130**. Alternatively, with the addition of the fiber tray sub-assembly and the housing **130** having connectors **94** of its back side, the housing **130** supports the CATV environment. The reconfigurable housing **130** adaptable for both markets reduces engineering, manufacturing and repair costs because a common housing **130** converts to support both environments.

For instance housing **130** tray be configured to couple to the chassis **10** in a first position in which it attaches to the rear of the chassis to form a Telco chassis **110**. By depending from the rear, the housing **130** allows access to connectors **94** from the chassis **110** front. Alternatively, housing **130** can be reconfigured slightly in shape and dimension and placed in a second, rear position on basic chassis **10** to form MSO chassis **70**. From the second position, housing **130** allows rear access to connectors **94**. Skilled persons will recognize that housing **130** could be reconfigured to couple with sides, or top of the chassis.

FIG. **19** also depicts the selected path of air exhaust for the each chassis. In the Telco chassis **110**, air flows **91** from the bottom of the chassis **110** through the chassis and exhausts out the front of the chassis. This selected air flow path eliminates or at least substantially limits the chimney effect when Telco chassis **110** mount in a rack **88** in a back-to-back configuration. Optionally, Telco chassis **110** utilize a rear air exhaust when vertically stacked in a rack **88**. In a CATV environment where chassis stack vertically in rack **88**, the MSO chassis **70** draws air **91** from the bottom of the chassis and exhausts the air **91** out the rear also eliminating the chimney effect.

An advantage of this invention is that it provides a modular chassis adaptable to the cable, U.S. Telco and European Telco markets. The modularity reduces engineering and manufacturing costs. The invention also provides for an even distribution of air transfer through the chassis eliminating the chimney effect.

In light of the foregoing disclosure of this invention and description of certain preferred embodiments, those who are skilled in this area of technology will readily understand that various modifications and adaptations can be made without departing from the true scope and spirit of this invention. All such modifications and adaptations are intended to be covered by the following claims.

What is claimed is:

1. A reconfigurable chassis for providing thermal management of external electrical modules that are inserted into the chassis and removed from the chassis, the chassis comprising:

a housing into which modules are inserted, the housing having a front portion and a back portion and further having multiple guides for holding the modules;

a removable fan tray located on top of the housing, the re movable fan tray for holding fans in first and second positions, wherein, when the fans are located in the first position, air is directed from the front portion of the chassis, and wherein, when the fans are located in the second position, air is directed from the back portion of the chassis;

a removable rear connector panel for use when electrical cables coupled to the modules are to be accessed from the back portion of the housing, wherein the removable rear connector panel is mounted to the back portion of the housing for electrically coupling to the electrical cables that are coupled to the modules;

a removable panel bracket for use when the electrical cables coupled to the modules are to be accessed from the front portion of the housing, wherein the removable panel bracket is mounted beneath the housing for routing the electrical cables from the back portion of the housing to the front portion of the housing; and

a removable front connector panel for use when the electrical cables coupled to the modules are to be accessed from the front portion of the housing, wherein the removable front connector panel is mounted to the front portion of the housing for electrically coupling to the electrical cables that have been routed through the removable panel bracket.

2. The reconfigurable chassis of claim **1**, wherein the electrical cables comprise coaxial cables.

3. The reconfigurable chassis of claim **1**, wherein the removable fan tray includes mounting means for holding the fans.

4. The reconfigurable chassis of claim **3**, wherein the removable fan tray includes vent holes formed in the front portion of the chassis.

5. The reconfigurable chassis of claim **3**, wherein the removable fan tray includes vent holes formed in the back portion of the chassis.

6. The reconfigurable chassis of claim **1**, wherein the removable rear connector panel comprises an interior surface, which faces towards the modules when the remov-

able rear connector panel is coupled to the back portion of the housing, and an exterior surface, which faces away from the modules when the removable rear connector panel is coupled to the back portion of the housing.

7. The reconfigurable chassis of claim **6**, wherein the removable rear connector panel further comprises electrical connectors corresponding to the electrical cables that are coupled to the modules, the electrical connectors having a first coupling mechanism, formed on the interior surface, for directly connecting to the electrical cables and having a second coupling mechanism, formed on the exterior surface, for providing electrical access to the electrical cables.

8. The reconfigurable chassis of claim **1**, wherein the removable front connector panel comprises an interior surface, which faces towards the removable panel bracket when the removable panel bracket and the removable front connector panel are coupled to the housing, and an exterior surface, which faces away from the removable panel bracket when the removable panel bracket and the removable front connector panel are coupled to the housing.

9. The reconfigurable chassis of claim **8**, wherein the removable front connector panel comprises electrical connectors corresponding to the electrical cables that are coupled to the modules, the electrical connectors having a first coupling mechanism, formed on the interior surface, for directly connecting to the electrical cables and having a second coupling mechanism, formed on the exterior surface, for providing electrical access to the electrical cables.

10. The reconfigurable chassis of claim **1**, further comprising:

a fiber guide bracket mounted to the housing for optically coupling to fiber cables that are coupled to the modules.

11. The reconfigurable chassis of claim **10**, wherein the fiber guide bracket includes optical connectors that are optically coupled to the fiber cables and that are accessible from the front portion of the housing.

* * * * *

UNITED STATES PATENT AND TRADEMARK OFFICE

CERTIFICATE OF CORRECTION

PATENT NO. : 6,195,493 B1
DATED : February 27, 2001
INVENTOR(S) : Bridges

It is certified that error appears in the above-identified patent and that said Letters Patent is hereby corrected as shown below:

In the Abstract delete "When the electrical cables coupled to the modules are to be accessed front the front portion of the housing, a removable front connector panel is also used, and the removable front connector panel is mounted to the front portion of the housing for electrically coupling to the electrical cables that have been routed through the removable panel bracket."
And insert therefore -- When the electrical cables coupled to the modules are to be accessed from the front portion of the housing, a removable front connector panel is also used, and the removable front connector panel is mounted to the front portion of the housing for electrically coupling to the electrical cables that have been routed through the removable panel bracket. --

Signed and Sealed this

Seventh Day of August, 2001

Attest:

Nicholas P. Godici

Attesting Officer

NICHOLAS P. GODICI
Acting Director of the United States Patent and Trademark Office

US006052278A

United States Patent [19]

Tanzer et al.

[11] Patent Number: 6,052,278

[45] Date of Patent: Apr. 18, 2000

[54] **DATA STORAGE MODULE AND ENCLOSURE SYSTEM**

[75] Inventors: **Herbert J. Tanzer**, Folsom; **Henry Jupille**, Placerville; **Kenneth K. Tang**, Sacramento, all of Calif.; **Darrel Poulter**, Middleton, Id.

[73] Assignee: **Hewlett-Packard Company**, Palo Alto, Calif.

[21] Appl. No.: **09/191,292**

[22] Filed: **Nov. 13, 1998**

[51] **Int. Cl.**[7] **G06F 1/16**; G11B 33/08

[52] **U.S. Cl.** **361/685**; 361/728; 361/747; 361/725; 361/732; 312/333; 312/223.3

[58] **Field of Search** ..... 361/685, 686, 361/684, 683, 728–733, 747, 725, 726, 727; 360/97.01, 98.01, 137, 137 D; 312/332.1, 333, 223.2; 369/75.1–82; 439/152–160, 928, 928.1

[56] **References Cited**

U.S. PATENT DOCUMENTS

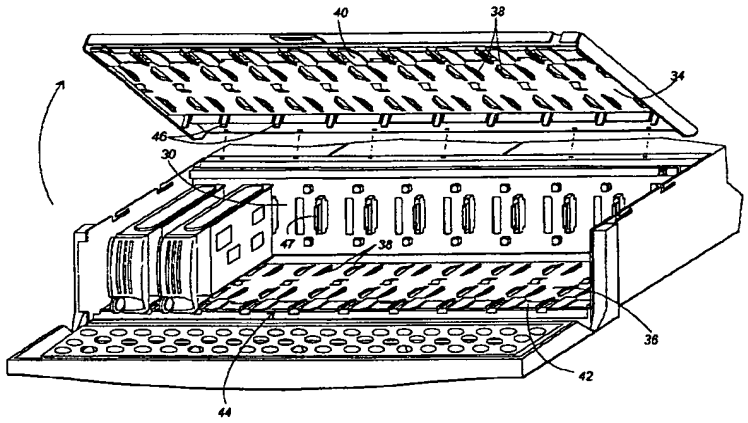
4,888,549	12/1989	Wilson et al.	324/73 R
5,212,681	5/1993	Bock et al.	369/244
5,247,427	9/1993	Driscoll et al.	361/685
5,583,745	12/1996	Uwabo et al.	361/685
5,586,003	12/1996	Schmitt et al.	361/683
5,652,695	7/1997	Schmitt	361/685
5,668,696	9/1997	Schmitt	361/685
5,691,879	11/1997	Lopez et al.	361/685
5,926,366	7/1999	Collins et al.	361/685

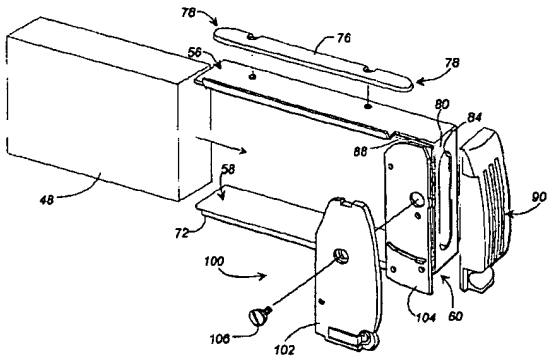
Primary Examiner—Leo P. Picard
Assistant Examiner—Anatoly Vortman

[57] **ABSTRACT**

A data storage module and enclosure system generally comprising a data storage module enclosure and a plurality of data storage modules. The module enclosure includes top and bottom guide plates that define a plurality of data storage module bay slots. Normally, the top guide plate includes a plurality of compliant tabs that are adapted to engage the data storage modules when fully inserted, and a lock rail that is used secure the module in place within its bay slot. The data storage modules each include a data storage device, such as a disk drive, and a module carrier. The module carrier includes a canister having an open configuration. Normally mounted to the front side of the canister is a bezel which is contoured to fit the user's hand and which includes a finger cavity that facilitates carrying of the module.

38 Claims, 5 Drawing Sheets





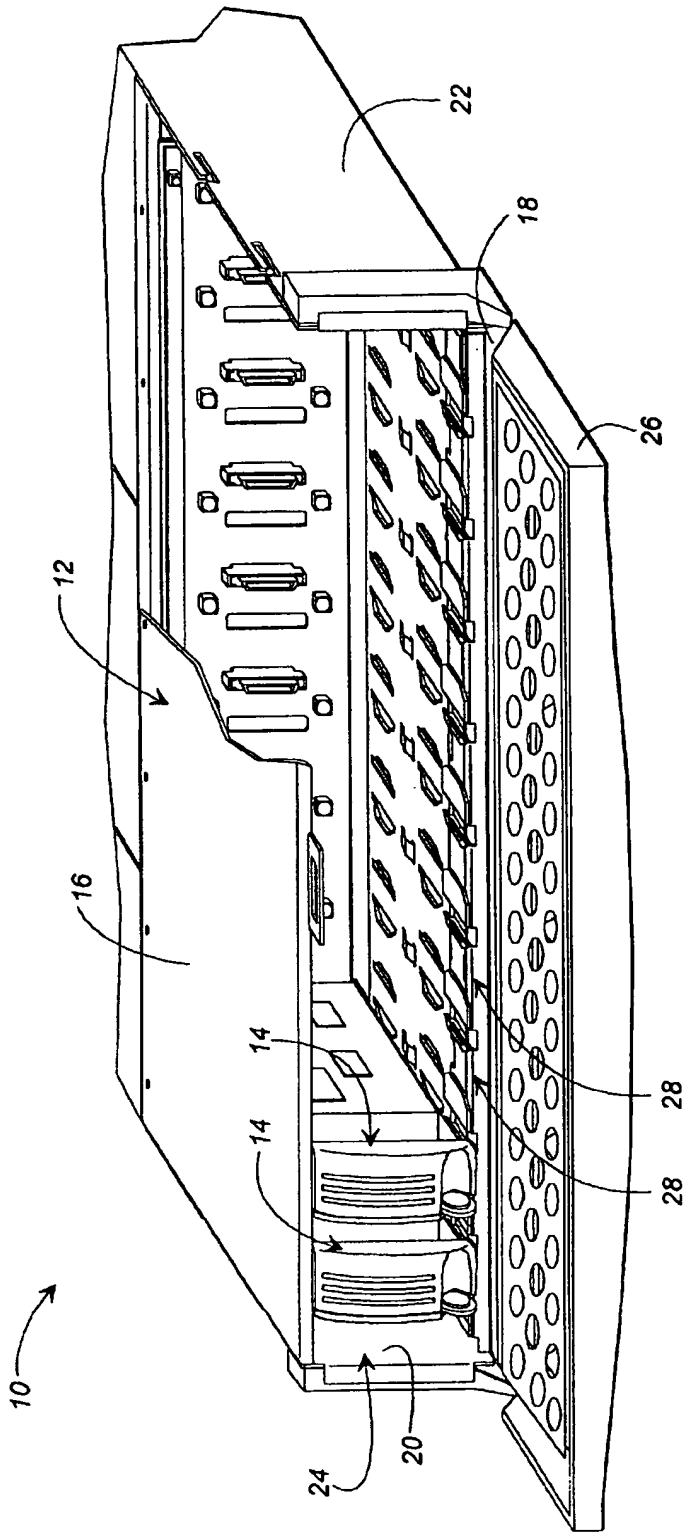


FIG. 1

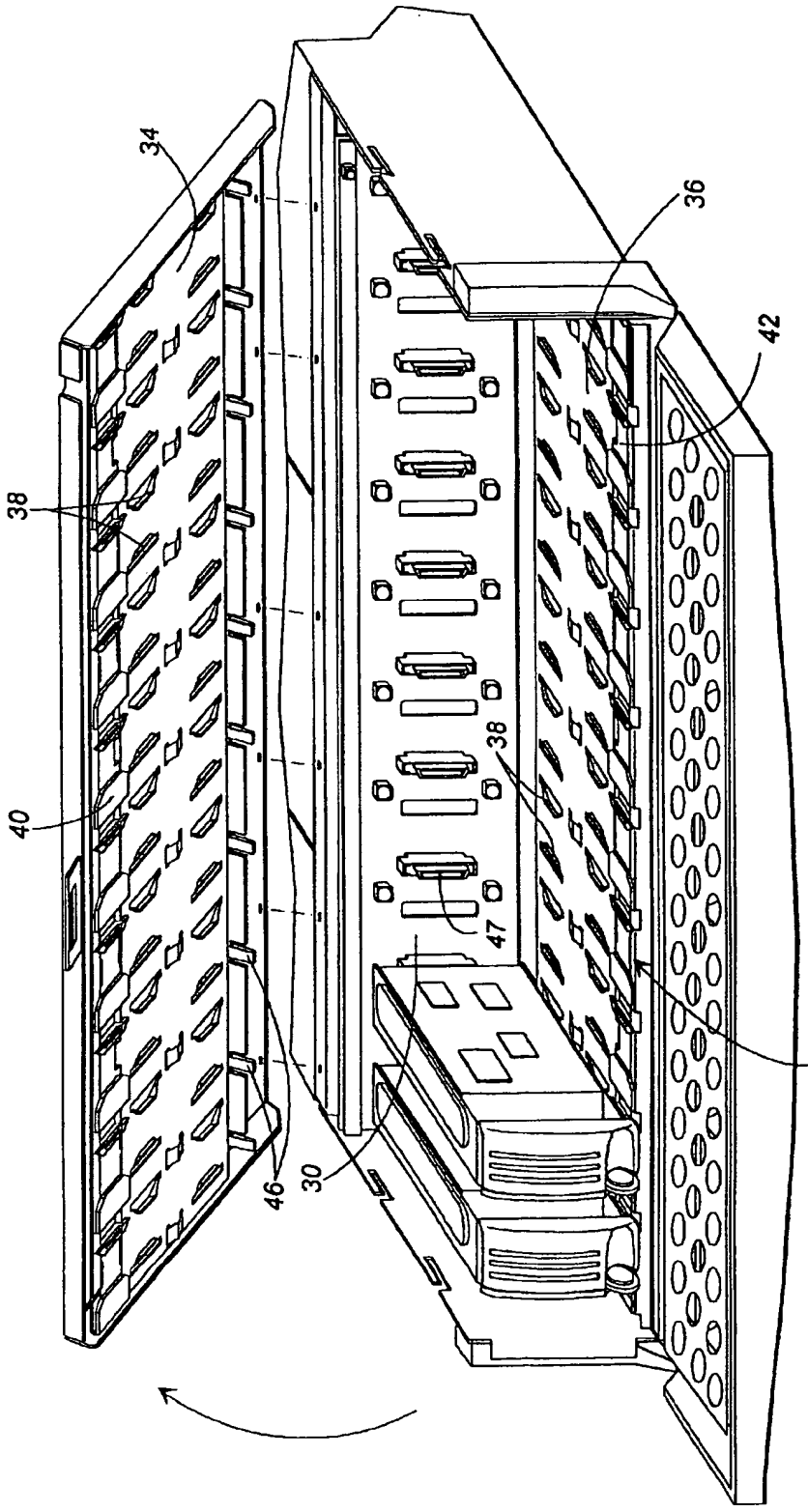


FIG. 2

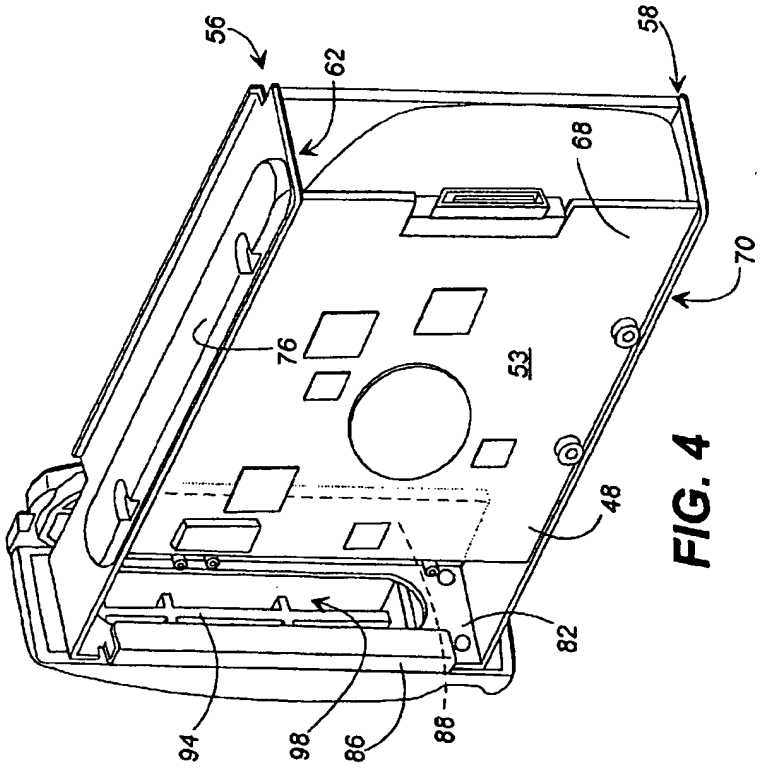

56
62
58
68
70
76
53
48
82
94
98
86
88

FIG. 4

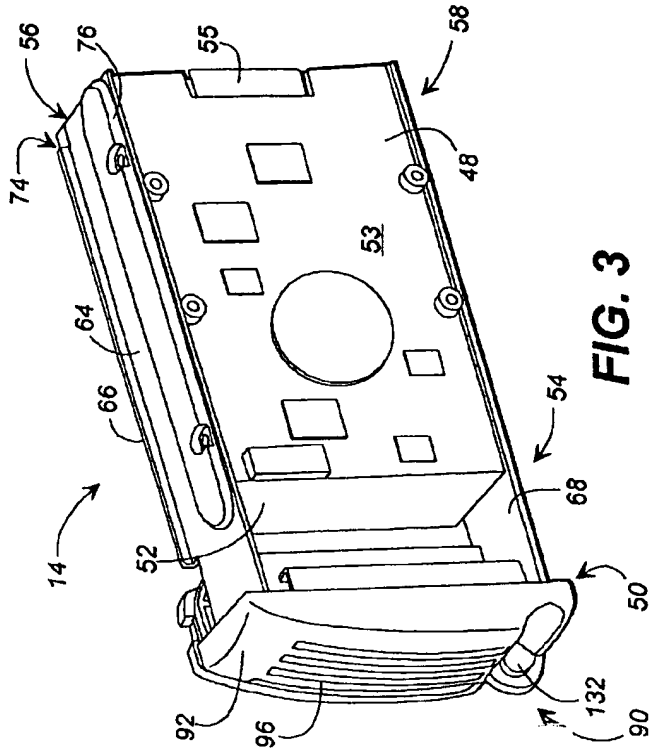

56
76
55
58
74
48
53
64
66
54
68
14
52
50
92
96
132
90

FIG. 3

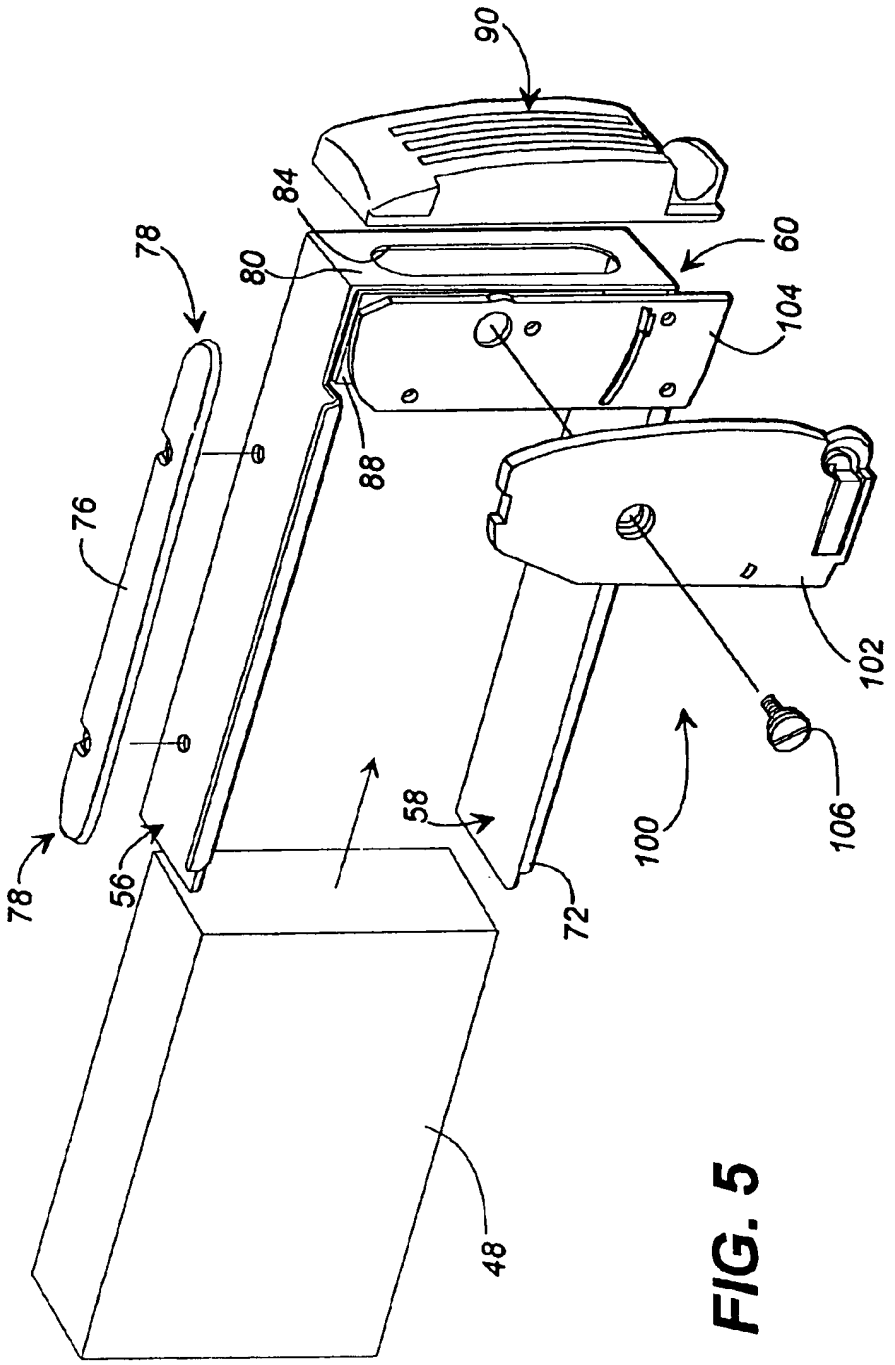


FIG. 5

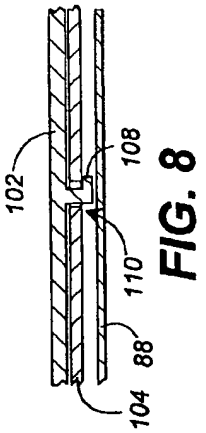


FIG. 8

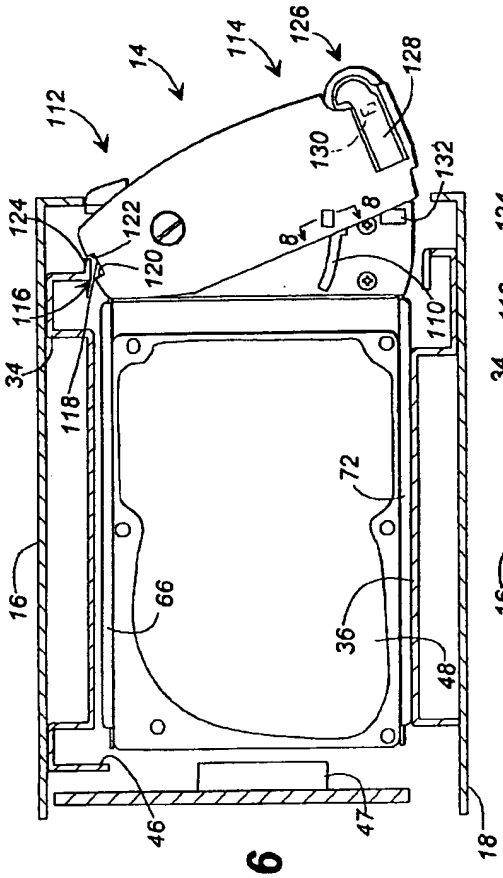


FIG. 6

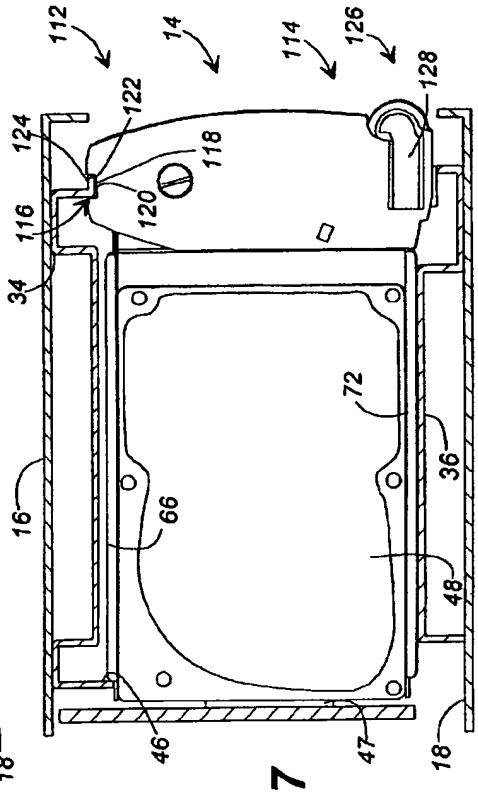


FIG. 7

DATA STORAGE MODULE AND ENCLOSURE SYSTEM

FIELD OF THE INVENTION

The invention relates generally to a data storage module and enclosure system. More particularly, the invention relates to a data storage module and enclosure system which provides for improved rotational vibration control, improved electrical connector engagement, and increased mass storage density within the module enclosure.

BACKGROUND OF THE INVENTION

Data storage equipment components typically comprise a plurality of data storage modules that slidably dock within a module enclosure formed at the front end of the component. Normally, the data storage modules include disk drives which each include a plurality of internal disks or platters that spin at high speeds within the drive during operation. Although there are numerous data storage modules and module enclosures used in the industry today, none satisfy all of the performance requirements of present data storage systems.

As is known in the art, the platters of the latest generation disk drives spin at speeds as high as 14K rpm creating gyroscopic forces that, in turn, create rotational vibrations. These vibrations can cause the individual spinning platters within the drive to contact each other (known as "head slap") which can be damaging to the platters. In previous systems, elastomeric bushings have been used in an effort to dampen such vibrations. Although these bushings appear to effectively protect the drive from external shock and vibrations, they do not completely dampen the internally generated vibrations created by the platters.

In addition to these vibrational problems, conventional storage systems create difficulties with regard to electrical connector engagement between the disk drive and the module enclosure backplane. Typically, the backplane and the disk drives are provided with mating multiple pin connectors that require relatively large forces to engage and disengage. Coupling of the connectors in conventional systems has been problematic in that there has been difficulty in obtaining the proper degree of engagement between the two connectors. When the disk drive connector does not fully engage with the backplane connector, intermittent signal losses can occur. On the other hand, when the disk drive connector is forced too harshly against the backplane connector, the connector solder joints can be damaged resulting in poor reliability of connection. The previous solution to such connection problems has been to use extremely low tolerance components which, it is intended, ensure proper engagement between the connectors of the disk drives and the backplane. Unfortunately, obtaining the tolerances needed for nominal mating of the connectors has proven to be extremely difficult from a manufacturing standpoint.

Another problem associated with conventional data storage systems is that mass storage density within the module enclosures is not maximized. Specifically, the dimensions of conventional data storage modules do not permit the maximum amount of packing possible in view of the dimensions of the disk drives themselves.

From the above, it can be appreciated that it would be desirable to have a data storage module and enclosure system which solves the above-identified problems.

SUMMARY OF THE INVENTION

Briefly described, the present invention relates to a data storage module and enclosure system generally comprising

a data storage module enclosure and a plurality of data storage modules. The module enclosure includes a frontal opening, a backplane having a plurality of electrical connectors mounted thereto, and top and bottom guide plates that define a plurality of module bay slots. Normally, the top guide plate includes a plurality of compliant tabs that are adapted to engage the data storage modules when fully inserted, and a lock rail that is used to secure the module in place within its bay slot.

The data storage modules each include a data storage device, such as a disk drive, and a module carrier. The module carrier includes a canister to which the data storage device can be fixedly mounted and a latch mechanism that locks the data storage module in place within its bay slot when the data storage device is fully inserted within the module enclosure. Typically, the canister only has top, bottom, and front sides so as to be arranged in an open configuration to increase module packing density and improve heat dissipation. The top side of the canister has an end notch that is adapted to abut one of the compliant tabs of the module enclosure when the data storage module is fully inserted within the module enclosure to control final insertion of the module.

Normally mounted to the front side of the canister is a bezel. The bezel usually is contoured to fit the user's hand and includes a finger cavity that, together with an elongated finger opening typically provided in the front side of the canister, facilitates carrying of the module.

The particular objects, features, and advantages of this invention will become more apparent upon reading the following specification, when taken in conjunction with the accompanying drawings. It is intended that all such additional features and advantages be included therein with the scope of the present invention, as defined by the claims.

BRIEF DESCRIPTION OF THE DRAWINGS

The invention can be better understood with reference to the following drawings. The components in the drawings are not necessarily to scale, emphasis instead being placed upon clearly illustrating the principles of the present invention. In the drawings, like reference numerals designate corresponding parts throughout the several views.

FIG. **1** is an upper right perspective view of a data storage module and enclosure system constructed in accordance with the present invention.

FIG. **2** is an upper right perspective view of the module enclosure shown in FIG. **1**, with the upper side of the enclosure shown detached from the enclosure.

FIG. **3** is an upper front perspective view of a data storage module shown in FIG. **1**.

FIG. **4** is an upper rear perspective view of the data storage module shown in FIG. **3**.

FIG. **5** is an upper front exploded view of the data storage module shown in FIGS. **3–4**.

FIG. **6** is a side view of a data storage module similar to that shown in FIGS. **1–4**, inserted within a module enclosure in the unlatched position.

FIG. **7** is a side view of the data storage module and module enclosure shown in FIG. **6**, depicting the module in the latched position.

FIG. **8** is cross-sectional view taken along lines **8—8** shown in FIG. **6**.

DETAILED DESCRIPTION OF THE INVENTION

Referring now in more detail to the drawings, in which like reference numerals indicate corresponding parts

throughout the several views, FIG. **1** illustrates a data storage module and enclosure system **10** constructed in accordance to the present invention. The system **10** generally comprises a module enclosure **12** that forms part of an equipment component, and a plurality of data storage modules **14** that can be slidably inserted within the module enclosure **12**.

As indicated in FIG. **1**, the module enclosure **12** comprises a substantially rectilinear housing which includes a top side **16**, bottom side **18**, and a pair of opposed lateral walls **20** and **22**. The front of the enclosure **12** forms a frontal opening **24** such that the module enclosure **12** has an open-faced configuration. Typically, an enclosure door **26** is pivotally mounted to the module enclosure **12** at the bottom of the frontal opening **24** to close the module enclosure **12** during normal operation. Inside the module enclosure **12** is a plurality of module bay slots **28** that extend linearly from the front of the enclosure to a main circuit board or backplane **30** of the system positioned at the rear of the enclosure **12**. Each of the module bay slots **28** is adapted to receive a data storage module **14**. As is apparent from FIG. **1**, when the data storage modules **14** are inserted within the enclosure **12**, the data storage modules **14** are tightly packed with respect to each other such that the system provides for a very high mass storage density.

Mounted to the top and bottom sides **16** and **18** inside the enclosure **12** are top and bottom guide plates **34** and **36**. These guide plates **34, 36** typically are composed of sheet metal and include inner guide tracks **38** that guide the data storage modules **14** along their respective bay slots **28**, although it will be appreciated that the guide plates **34, 36** could be constructed of a suitable polymeric material, if desired. Furthermore, although depicted as being constructed as separate parts, the top and bottom guide plates could be formed unitarily with the top and bottom sides, respectively. Adjacent the frontal opening **24** of the enclosure **12** are top and bottom alignment guides **40** and **42**, respectively. Each alignment guide **40, 42** is provided with a plurality of channels **44** that guide the data storage modules **14** to the inner guide tracks **38** of the guide plates **34** and **36**. As is discussed below, the channels **44** and the inner guide tracks **38** aid the user in aligning the data storage modules **14** in their respective bay slots **28** such that the data storage device within the module can be properly connected to a multiple pin connector **47** mounted to the backplane **30**.

As indicated in FIG. **2**, the top guide plate **34** mounted to the top side **16** of the module enclosure **12** includes a plurality of compliant tabs **46** which individually abut the data storage modules **14** when the modules are fully inserted within the enclosure. The compliant tabs **46** typically comprise relatively stiff metal springs that are unitarily formed with the top guide plate **34**. As is discussed in more detail below, these tabs protect the multiple pin connectors of the data storage module **14** and the module enclosure **12** and ensure that proper engagement is made therebetween.

FIGS. **3–5** illustrate the data storage module **14** in detail. As shown in these figures, the data storage module **14** generally comprises a data storage device **48** and a data storage device carrier **50**. Typically, the data storage device **48** comprises a disk drive that generally comprises a sealed housing **52** which encloses a head/disk assembly comprising one or more disks or platters which are rotated at constant speed during operation (not shown). Outside of the sealed housing **52** is a circuit board **53** that includes a multiple pin connector **55**. As is known in the art, disk drives are high precision instruments that are designed to provide thousands of hours of trouble free operation in mechanically stable environments. However, as discussed above, the high rotational speeds of the platters create gyroscopic forces that can cause excessive rotational vibrations that, if not properly attenuated, can interfere with proper drive operation and can even permanently damage the platters.

The data storage device carrier **50** comprises a data storage device canister **54** that, as shown most clearly in FIG. **5**, includes a top side **56**, a bottom side **58**, and a front side **60**. Typically, the canister **54** is unitarily constructed from a single piece of sheet metal which is folded to form the aforementioned sides of the canister. Although unitary construction is preferred, it is to be understood that alternative construction is possible, if desired. As shown in FIGS. **3–4**, the data storage device **48** fixedly mounts to the top and bottom sides **56** and **58** of the canister **54** with conventional fasteners such as screws or bolts. Normally, the sides of the canister **54** do not include side walls such that the canister has an open configuration and such that the data storage device **48** mounted thereto is exposed to the ambient air. The absence of such side walls provides for greater packing density of the data storage modules **14** within the module enclosure **12** and further provides for improved heat dissipation by increasing access to cooling air drawn through the system. With the open canister configuration, each data storage module **14** can be spaced from the next by a distance as small as 2 mm.

The top and bottom sides **56** and **58** of the canister **54** typically are substantially planar and rectilinear in shape. The top side **56** includes inner and outer surfaces **62** and **64** and a side flange **66** which extends outwardly from the outer surface **64** of the top side **56**. Similarly, the bottom side **58** includes inner and outer surfaces **68** and **70** and a side flange **72** which extends outwardly from the outer surface **70** of the bottom side **58**. Each of the top and bottom sides **56** and **58** is provided with an end notch **74** positioned at the rear of the canister **54**. As is discussed below, at least the top end notch **74** is adapted to receive one of the compliant tabs **46** of the module enclosure **12**. Mounted to the outer surfaces **64** and **70** of the top and bottom sides **56** and **58**, respectively, are guide rails **76** which are adapted to be received by the channels **44** of the alignment guides **40, 42** of the module enclosure **12**. These guide rails **76** align with the alignment guides **40, 42** as well as the inner guide tracks **38** formed on the top and bottom guide plates **34** and **36** of the module enclosure **12** to facilitate insertion of the data storage modules **14** into the module enclosure **12**. As shown in FIGS. **3–5**, the guide rails **76** have substantially tapered ends **78** which simplify the insertion process. Typically, the guide rails **76** are constructed of a relatively soft material such as a polymeric material such that the guide rails dampen shocks and slide smoothly along the channels **44** and guide tracks **38** during module insertion.

The front side **60** of the canister **54** is substantially planar and rectilinear in shape and comprises a front surface **80**, a rear surface **82**, and an elongated finger opening **84**. The front side **60** further comprises an angled flange **86** that extends from the lateral edge of the front side. As indicated most clearly in FIGS. **3** and **4**, the angled flange **86** extends rearwardly from the front surface **80** of the front side **60** for a distance and then extends inwardly at a generally right angle. Together with the elongated finger opening **84**, the angled flange **86** facilitates handling of the data storage module **14**. Extending from the other lateral edge of the front side **60** is a latch mechanism mounting flange **88**. As shown in FIG. **5**, the mounting flange **88** is substantially planar and rectilinear in shape and extends rearwardly from the front side **60** in a plane generally perpendicular to that comprising the front side.

Mounted to the front surface **80** of the front side **60** of the canister **54** is a bezel **90**. As depicted in FIGS. **3–5**, the bezel **90** has a substantially convex outer surface **92** which is generally contoured to fit the shape of the user's palm, and a substantially planar inner surface **94** which is adapted to engage the front surface **80** of the front side **60** of the canister **54**. Normally, the bezel **90** is composed of a durable polymeric material and is heat staked in place on the front side of the canister. The bezel **90** includes a plurality of air inlets **96** that are used to draw air into the module enclosure **12** from the atmosphere for cooling of the data storage devices **48**. As illustrated in FIG. **4**, the inner surface **94** includes a finger cavity **98** which, together with the elongated finger opening **84** and the angled flange **86**, facilitates handling of the data storage module **14**.

As shown in FIG. **5**, a latch mechanism **100** is mounted to the latch mechanism mounting flange **88**. The latch mechanism **100** generally comprises a latch lever **102** and a latch lever retainer **104**. Typically, the latch lever **102** and the latch lever retainer **104** are both substantially planar in shape and constructed out of a durable polymeric material. Although planar, each of the latch lever and the latch lever retainer is robust in design in comparison to previous module latch mechanisms to better withstand the loading forces imposed thereon during latching and unlatching of the data storage module **14** as well as forces that could be imposed on the module if it is accidentally dropped. The latch lever retainer **104** mounts directly to the latch mounting flange **88** with a plurality of conventional fasteners, and the latch lever **102** pivotally mounts to the latch lever retainer **104**, and the remainder of the disk drive carrier **50**, with another conventional fastener **106** such as a shoulder screw. The axis of the shoulder screw forms a pivot point about which the latch lever **102** can angularly pivot. The extent to which the latch lever **104** can pivot is limited by an L-shaped follower **108** that is formed on the latch lever that travels along an arcuate slot **110** formed in the latch lever retainer **104** as indicated in FIGS. **6–8**.

The latch lever **102** generally comprises a latch end **112** and a handle end **114** as indicated in FIGS. **6–7**. At the latch end **112** is a lock notch **116** that is defined by a notch base **118** and leading and trailing edges **120** and **122**. Arranged in this manner, the lock notch **114** is adapted to receive a lock rail **124** of the top guide plate **34** positioned adjacent the frontal opening **24** of the module enclosure **12**. At the handle end **114** of the latch lever **102** is a handle **126** which surrounds a flexible cantilever latch member **128**. Typically, the cantilever latch member **128** takes the form of an elongated, substantially planar member which is formed unitarily with the latch lever **102**. On the inner surface of the latch member **128** is a catch **130** (indicated with hidden lines) that is sized and shaped for receipt by a catch notch **132** formed in the latch lever retainer **104**. As shown in FIG. **3**, a finger tab **132** is formed at the distal end of the cantilever latch member **128** which provides a surface that the user can press when the data storage module **14** is to be removed from the module enclosure **12**. As indicated most clearly in FIG. **1**, the handle **126** typically is laterally displaced towards the center of the data storage module **14** relative to the latch mechanism **100** to provide a visual indication to the user as to which handle belongs to which module.

The primary structural features of the invention having been described above, the insertion of the data storage module **14** into the module enclosure **12** will now be discussed. When a data storage module **14** is to be inserted into a bay slot **28** of the module enclosure **12**, the latch lever **102** is placed in the unlatched position depicted in FIG. **6**. To insert the module **14**, the module is first aligned with the selected bay slot **28** by inserting the guide rails **76** of the module into the channels **44** of the top and bottom alignment guides **40** and **42**. Once the guide rails **76** are correctly aligned within these channels **44**, the data storage module **14** can be slid forwardly into the module enclosure **12**. The guide rails **76** pass smoothly along the alignment guide channels **44** and eventually engage the inner guide tracks **38** that are provided along the top and bottom guide plates **34** and **36** inside the module enclosure **12**.

When the data storage module **14** has nearly been fully inserted into its bay slot **28**, contact is made between the trailing edge **122** of the latch lever lock notch **116** and the lock rail **124** of the module enclosure. Continued insertion of the module **14** causes the latch lever **102** to rotate in the clockwise (latching) direction due to the force imparted by the lock rail **124** to the trailing edge of the lock notch **116**. At this point, the data storage device multiple pin connector **55** first contacts its mating multiple pin connector **47** mounted to the backplane **30** positioned inside the enclosure **12**. Insertion of the data storage module **14** can then be completed by gripping the handle **126** between the thumb and index finger, by example, and pushing it forwardly. This pushing motion further rotates the latch lever **102** in the clockwise direction and brings the leading edge **120** of the notch **118** in contact with the lock rail **124**. As the handle **126** is pushed, the forces exerted on the leading edge **120** by the lock rail **124** urges the data storage module **14** forward the remainder of the distance needed to attain complete engagement of the multiple pin connectors **47**, **55**. As indicated in FIG. **7**, latching is completed when the lock rail **124** is in firm contact with the notch base **118** of the latch lever **102** and the cantilever latch member catch **130** is received within the catch notch **132** of the latch lever retainer **104**.

Latching in this manner, the data storage module **14** can be quickly and easily electrically connected to the backplane **30** of the module enclosure **12**. Although a relatively large force is needed to connect the mating multiple pin connectors **47**, **55** of the data storage device **48** and the backplane **30**, the latch lever **102** provides a relatively large amount of leverage such that the user need only use finger pressure to complete the insertion of the module **14** and attain full engagement between the connectors. Once latched, the data storage module **14** is held tightly in place. In particular, the firm contact maintained between the lock notch **114** and the lock rail **124** transmits a relatively large amount of force along the latch lever **102** to the shoulder screw, and thereby to the remainder of the module **14**. Due to this force, the data storage module **14** may be said to be hard mounted within the module enclosure **12**. This hard mounting greatly attenuates the rotational vibrations created by the spinning platters and eliminates contact between the individual platters.

In addition to reducing the force needed to engage the multiple pin connectors **47**, **55**, the present system further ensures that the proper degree of engagement is had between the multiple pin connectors so that complete contact is made without damaging the connectors. In particular, the compliant tabs **46** of the module enclosure **12** make contact with the end notches **74** of the canisters **54** as shown in FIG. **7** to act as a resilient stop which both relieves some of the force that would normally be transmitted to the connectors and limits insertion of the data storage module to ensure that over engagement of the connectors does not occur. Although described herein as being formed with the top guide plate **34**, it will be appreciated that the compliant tabs **46** could be placed in any position within the module enclosure **12** in which the tabs would abut the data storage modules **14** when fully inserted within the enclosure.

To remove the data storage module **14** from the module enclosure **12**, the latch lever **102** must first be released. To release the lever **102**, the user again grips the handle **126** between the thumb and index finger, by example, and simultaneously presses the finger tab **132** inwardly (left in the embodiment shown in the figures) to release the catch **130** from the catch notch **132**. At this point, the latch lever **102** can be rotated in the counter-clockwise (unlatching) direction by pulling the handle **126** outwardly. The counter clockwise rotation of the latch lever **102** forces the trailing edge **122** of the lock notch **118** against the lock rail **124** of the module enclosure to slide the data storage module **14** outwardly from its bay slot **28** and disengage the multiple pin connectors **47, 55** within the enclosure.

Once the connectors **47, 55** have been fully disengaged, the entire data storage module **14** can be removed from the module enclosure **12** by gripping the module and pulling it outwardly from its bay slot **28**. The user can securely grip the module by wrapping his/her fingers around the bezel **90** and the angled flange **86** of the canister **54** such that his/her fingers extend through the finger opening **84** of the canister **54** and his/her fingertips are positioned within the finger cavity **98** formed in the bezel **90**. When gripped in this manner, the outer surface **92** of the bezel **90** fits within the user's palm such that the module **14** can be held comfortably in the user's hand. Accordingly, the bezel **90** and canister **54** can be said to together form an intuitive grab handle with which the data storage module **14** can be manipulated. Once completely withdrawn from the module enclosure **12**, the module **14** can be carried by the grab handle in manner described above.

The grab handle of the present invention presents advantages not realized in conventional systems. First, the grab handle permits the user to obtain a firm control over the module **14**. This is particularly important when the data storage is a latest generation disk drive in that the platters within the drive may still spin for 20 to 40 seconds after the data storage module **14** has been withdrawn and therefore is creating gyroscopic forces which could cause the user to lose his/her grip of the module. Second, the grab handle provides the user with way to carry the module **14** without having to touch the data storage **48** itself. This feature is important since the device **48** may be hot when first removed from the enclosure **12** or may have stored electrostatic charges, either of which could cause the user to drop the module **14**.

While preferred embodiments of the invention have been disclosed in detail in the foregoing description and drawings, it will be understood by those skilled in the art that variations and modifications thereof can be made without departing from the spirit and scope of the invention as set forth in the following claims.

Therefore, the following is claimed:

1. A data storage module and enclosure system, comprising:

a data storage module enclosure including a frontal opening, a backplane having a plurality of electrical connectors mounted thereto, and top and bottom guide plates that define a plurality of data storage module bay slots, one of said guide plates including a plurality of compliant tabs, one electrical connector and one compliant tab being aligned with each of said bay slots; and

at least one data storage module, said module including a data storage device and a module carrier, said data storage device including an electrical connector sized and configured to mate with one of said electrical connectors of said module enclosure backplane, said module carrier including a canister to which said data storage device is fixedly mounted and a latch mechanism including a latch lever and a latch retainer that locks said data storage module in place within its bay slot when said data storage device is fully inserted within said module enclosure, said canister having top, bottom, and front sides arranged in a manner such that said canister has an open configuration,

wherein one of said compliant tabs abuts said data storage module when said module is fully inserted within said module enclosure to both relieve a component of force that would normally be transmitted to said module and backplane connectors and to limit insertion of said data storage module within said module enclosure to ensure that over engagement of said connectors does not occur.

2. The system of claim **1**, wherein each of said guide plates includes an alignment guide positioned adjacent said frontal opening of said module enclosure and said at least one data storage module includes a guide rail mounted to each of said top and bottom sides of said canister, wherein said guide rails travel along channels formed in said alignment guides during insertion of said at least one data storage module within said module enclosure to ensure proper alignment of said module within its bay slot.

3. The system of claim **2**, wherein each of said alignment guides and said guide rails is composed of a polymeric material.

4. The system of claim **3**, wherein each of said guide plates includes a plurality of inner guide tracks spaced inwardly from said alignment guides, wherein said guide rails travel along said guide tracks during insertion of said at least one data storage module within said module enclosure to further ensure proper alignment of said module within its bay slot.

5. The system of claim **4**, wherein each of said guide plates is composed of a sheet metal material.

6. The system of claim **1**, wherein said top guide plate includes a lock rail positioned adjacent said frontal opening of said module enclosure and said latch mechanism includes a latch lever having a lock notch, wherein said lock notch receives and is in firm contact with said lock rail when said latch mechanism is in a latched position.

7. A data storage module adapted for insertion within a module enclosure, said data storage module comprising:

a module carrier including a canister having top, bottom, and front sides arranged in a manner such that said canister has an open configuration, a latch mechanism including a latch lever and a latch retainer mounted to said canister, and a bezel mounted to said front side of said canister, said front side of said canister including a finger opening and said bezel including a finger cavity, said finger opening and said finger cavity facilitating carrying of said data storage module; and

a data storage device having an electrical connector mounted thereto, said data storage device being fixedly mounted to said top and bottom sides of said canister.

8. The module of claim **7**, further comprising a guide rail mounted to each of said top and bottom sides of said canister, said guide rails being adapted to slide along alignment guides positioned within the module enclosure.

9. The module of claim **8**, wherein each of said guide rails has tapered ends which facilitate insertion and alignment of said data storage module within the module enclosure.

10. The module of claim **7**, wherein said top and bottom sides of said canister include side flanges that extend outwardly therefrom.

11. The module of claim 10, wherein said side flange of said top side of said canister forms an end notch that is adapted to abut a compliant tab positioned within the module enclosure.

12. The module of claim 7, wherein said latch mechanism comprises a latch lever having a lock notch that is adapted to receive a lock rail positioned within the module enclosure.

13. The module of claim 12, wherein said latch lever is substantially planar and further includes a handle, said handle being off-set with respect to the plane containing said latch lever so as to be positioned adjacent the center of said bezel.

14. The module of claim 7, wherein said bezel has an outer surface that is contoured to fit the palm of the carrier.

15. The module of claim 14, further comprising an angled flange extending rearwardly from said front side of said canister which further facilitates carrying of said data storage module.

16. The module of claim 7, further comprising a latch mechanism mounting flange extending rearwardly from said front side of said canister, said latch mechanism being mounted to said latch mechanism mounting flange.

17. The module of claim 7, wherein said data storage device is a disk drive.

18. A data storage module carrier for facilitating carrying of a data storage module and insertion of the module within a module enclosure, said module carrier comprising:

a data storage device canister having top, bottom, and front sides arranged in a manner such that said canister has an open configuration, said front side of said canister including a finger opening;

a latch mechanism including a latch lever and a latch retainer mounted to said canister; and

a bezel mounted to said front side of said canister, said bezel including a finger cavity;

wherein said finger opening and said finger cavity facilitating carrying of said data storage module.

19. The carrier of claim 18, further comprising a guide rail mounted to each of said top and bottom sides of said canister, said guide rails being adapted to slide along alignment guides positioned within the module enclosure.

20. The carrier of claim 19, wherein each of said guide rails has tapered ends which facilitate insertion and alignment of the data storage module within the module enclosure.

21. The carrier of claim 18, wherein said top and bottom sides of said canister include side flanges that extend outwardly therefrom.

22. The carrier of claim 21, wherein said side flange of said top side of said canister forms an end notch that is adapted to abut a compliant tab positioned within the module enclosure.

23. The carrier of claim 18, wherein said latch mechanism comprises a latch lever having a lock notch that is adapted to receive a lock rail positioned within the module enclosure.

24. The carrier of claim 23, wherein said latch lever is substantially planar and further includes a handle, said handle being off-set with respect to the plane containing said latch lever so as to be positioned adjacent the center of said bezel.

25. The carrier of claim 18, wherein said bezel has an outer surface that is contoured to fit the palm of the carrier.

26. The carrier of claim 25, further comprising an angled flange extending rearwardly from said front side of said canister which further facilitates carrying of the data storage module.

27. The carrier of claim 18, further comprising a latch mechanism mounting flange extending rearwardly from said front side of said canister, said latch mechanism being mounted to said latch mechanism mounting flange.

28. A method for using a data storage module including a lock mechanism in conjunction with a module enclosure including a plurality of bay slots, the method comprising the steps of:

aligning the data storage with one of the bay slots of the module enclosure;

inserting the data storage module into the module enclosure by sliding the data storage module forwardly along the selected bay slot until multiple pin connectors of the data storage module and the module enclosure make contact; and

completing insertion of the data storage module by pushing a latch lever of the latch mechanism forwardly into a latched position, this pushing motion rotating the latch lever to bring a notch formed in the latch lever in firm contact with a lock rail provided within the module enclosure and to position a latch member catch within a catch notch of a latch lever retainer to push the data storage module forwardly to achieve full engagement between the multiple pin connectors of the data storage module and the module enclosure.

29. The method of claim 28, wherein the step of aligning the data storage device comprises aligning guide rails provided on the data storage module with channels provided in alignment guides mounted within the module enclosure.

30. The method of claim 29, wherein the step of inserting the data storage module into the module enclosure comprises sliding the guide rails of the data storage module along the channels of the alignment guides.

31. The method of claim 28, wherein the latch lever locks in the latched position to secure the data storage module in a hard mounted orientation within the module enclosure.

32. The method of claim 28, wherein the final portion of insertion of the data storage module is completed against the force of a compliant tab provided within the module enclosure that acts as a resilient stop to relieve force that would normally be transmitted to the connectors and to limit insertion of the data storage module to ensure that over engagement of the connectors does not occur.

33. The method of claim 32, wherein the compliant tab is integrally formed with a chassis provided within the module enclosure.

34. The method of claim 28, further comprising the step of removing the data storage module from the module enclosure by

releasing the latch lever from the latched position,

pulling the latch lever outwardly until the multiple pin connectors are fully disengaged, and

pulling the data storage module outwardly from its bay slot.

35. The method of claim 34, wherein the step of releasing the latch lever comprises depressing a finger tab formed on the latch lever to release a catch formed on the latch lever from a catch notch formed on the latch mechanism.

36. The method of claim 34, wherein the step of pulling the latch lever outwardly rotates the latch lever to urge the latch lever notch against the lock rail to push the data storage outwardly from the module enclosure to disengage the multiple pin connectors.

37. The method of claim 34, wherein the step of pulling the data storage module outwardly from its bay slot comprises securely gripping the data storage module by wrapping one's fingers around a bezel mounted on the data storage module and placing one's fingers through a finger

opening formed in the data storage module such that one's fingertips are positioned within a finger cavity formed in the bezel.

38. The method of claim **37**, further comprising the step of carrying the data storage module by gripping the data storage module with one's fingers wrapped around the bezel and one's fingertips disposed in the finger cavity formed in the bezel.

* * * * *

US-PAT-NO: 6052278

DOCUMENT-IDENTIFIER: US 6052278 A

TITLE: Data storage **module** and enclosure system

DATE-ISSUED: April 18, 2000

INVENTOR-INFORMATION:

NAME	CITY	STATE	ZIP CODE	COUNTRY
Tanzer; Herbert J.	Folsom	CA	N/A	N/A
Jupille; Henry	Placerville	CA	N/A	N/A
Tang; Kenneth K.	Sacramento	CA	N/A	N/A
Poulter; Darrel	Middleton	ID	N/A	N/A

US-CL-CURRENT: 361/685; 312/223.3 ; 312/333 ; 361/725 ; 361/728 ; **361/732** ; 361/747

ABSTRACT:

A data storage **module** and enclosure system generally comprising a data storage **module** enclosure and a plurality of data storage **modules**. The **module** enclosure includes top and bottom guide plates that define a plurality of data storage **module** bay slots. Normally, the top guide plate includes a plurality of compliant tabs that are adapted to engage the data storage **modules** when fully inserted, and a lock rail that is used secure the **module** in place within its bay slot. The data storage **modules** each include a data storage device, such as a disk drive, and a **module** carrier. The **module** carrier includes a canister having an open configuration. Normally mounted to the front side of

the canister is a bezel which is contoured to fit the user's hand and which
includes a finger cavity that facilitates carrying of the **module**.

38 Claims, 8 Drawing figures

Exemplary Claim Number: 1

Number of Drawing Sheets: 5